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THE DIAGNOSIS AND TREATMENT OF PRIMARY CARCINOMA OF THE BRONCHUS OR LUNG

CALDWELL LECTURE*

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IT HAS been only within very recent years that primary carcinoma of the bronchus or lung has been removed from the realm of the "rare and unusual" to the commonplace. Textbooks of both pathology and medicine published less than a decade ago state that this condition constitutes only about 1 per cent or less of all carcinomas. If this were true there would be little justification for appearing before you to discuss this subject. On the contrary, however, we now know that primary carcinoma of the lung constitutes between 5 and 10 per cent of all carcinomas, and some writers have given to it even a higher percentage of incidence. The collected summary of Junghanns is particularly instructive on this point. The condition is comparable, therefore, with carcinoma of the large intestine and with other carcinomas which have received far more attention and emphasis. It has been and probably often still is overlooked even at autopsy because the complicating features of pulmonary suppuration may overshadow the carcinoma to such an extent that even the possibility of the presence of such a condition may not be considered.

The exact origin of primary carcinoma of the lung is still under discussion. There is no doubt that practically all, if not all of them, arise in a bronchus. Also, the bronchus which is the site of origin is usually one of the primary divisions of one of the main bronchi, or at least one which contains cartilage in its wall. Fried has collected evidence which indicates that the source of the various cellular types is the undifferentiated basal cell of the bronchial mucous membrane which is the cell chiefly concerned in the process of repair of that tissue. He has also cast serious doubt upon the epithelial nature of the cells lining the pulmonary alveoli which he considers to be of mesoblastic origin. The fact therefore that some of these tumors are composed of squamous cells, come are adenocarcinomas, others have "oat-cells" and others present still different cellular structures or a combination of many of them is, according to him, all to be explained on the basis of a transformation of the basal cell into one of these various types of cells of which different tumors are seen to be composed. Moreover, his conceptions would rule out the possibility of a primary carcinoma

* Delivered before the American Roentgen Ray Society during the American Congress of Radiology, Chicago, Sept. 25–30, 1933.

which originates in the alveolar epithelium for the simple reason that there is no tissue of that sort.

These newer ideas are markedly at variance with the older conceptions that some tumors arise from the ciliated cylindrical epithelium, some from the mucous glands and others from the alveolar epithelium. Further work will be required to establish what the facts are. But regardless of the controversy over the exact site of origin, it seems to be well established that certain tumors ulcerate rather early and produce either a stenosis or a complete obstruction of the bronchus. These features have important clinical consequences because they give rise not only to the presence of blood in the sputum but also to the sequelae of bronchial stenosis, such as atelectasis, bronchiectasis, abscess formation, etc. On the other hand, a more rare type which has often been regarded as one arising in the mucous glands usually grows more diffusely along and around the bronchus beneath the mucosa and is slower to ulcerate. Bronchial obstruction is said to be less frequent in this type. It is obvious then that in this type the common clinical features of the other type such as hemoptysis, atelectasis, pulmonary suppuration, etc., would be slower in making their appearance, and moreover, it would be more difficult to recognize this type through the bronchoscope than the former type.

Metastases may occur in any organ, and often the initial symptoms and signs of importance arise from the metastatic rather than from the primary lesion. This is particularly the case with metastases to the brain and to the long bones. Rogers, after reviewing 50 necropsy cases, concluded that in as many as 44 per cent the first symptoms were produced by the metastasis rather than by the primary tumor. As might be expected, the most frequent sites of metastasis are the pleura, the lung and the mediastinal lymph glands. Following these in frequency, in our own cases, come the liver, the genitourinary system and the central nervous system.

It is well known that the duration of a bronchial carcinoma is extremely variable. Some cases are relatively benign and others pursue a rapid course. The factors which cause this variability in duration are not clearly understood. Perhaps one of the factors is the nature of the predominating type of cell. Up to the present, however, the reported cases have been so inadequately studied from this standpoint that it is impossible to generalize. Carlson and Ballon, in a study of 26 of our cases at the Barnes Hospital which were proved by autopsy, found that 6 of the patients survived two years or more after the onset of their symptoms and that one patient had survived five years, another one four years and a third, three and one-half years. The average survival, however, after the onset of symptoms was less than two years.

The symptoms presented by the 26 patients upon whom post-mortem examinations were made are given in Table 1.

Although a far greater number of patients have been seen at the Chest Service of Barnes Hospital and diagnosed as having primary carcinoma of the lung, only the 26 patients whom we were able to follow to the post-mortem examination have been included in this series because it is only in that group that we have felt we could have a complete and satisfactory knowledge of the patient with reference to the condition of the lungs, the presence and extent of metastases, etc. Many more patients than are represented in this series left the hospital after the diagnosis was made and died at home. In nearly all of those cases no autopsy was performed. Many others are still living.

The diagnosis of a primary carcinoma of the bronchus can be made in practically every instance if the possibility of the condition is considered. Doubtless the principal reason for failure is the current idea that the lesion is so rare that there is no need to consider it. In our own experience we have found that most of the failures to recognize the condition by the referring physicians have been due to a failure to

TABLE I

SYMPTOMS UPON ADMISSION TO HOSPITAL
(26 necropsy cases)

(Patients Observed at the Medical and Surgical Chest Service, Barnes Hospital)

I. Local Pulmonary Symptoms (Grouped according to Frequency)

	No. Cases
Cough	17
Chest pain or discomfort	11
Dyspnea	11
Sputum	10
Hemoptysis or "streaking"	6
"Chest colds"	2
(No chest symptoms 5)	

II. General Symptoms

	No. Cases
Weight loss	9
Weakness	6
Anorexia	3
Night sweats	2
Thirst	1
Fatigue	1

III. Symptoms Suggestive of "Extension," Metastases or Unrelated Disease

	No. Cases
Nervous symptoms*	8
Pain in back or extremities (not related to nerve pathways)	7
Urinary symptoms	3
Vomiting	2
Abdominal pain	2
Abdominal enlargement	1
Engorgement of veins	1
Precordial distress	1
Dysphagia	1

*Including pain of typical distribution in 2 cases.

consider the possibility of its presence. Although the absolute diagnosis of a primary bronchogenic carcinoma will usually depend on the use of the bronchoscope for the removal of a piece of tissue for microscopic examination, there are, nevertheless, several features of the clinical history and examination, supplemented by a roentgenologic examination, which should arouse at least a strong suspicion of its presence. These features are particularly the insidious onset and persistence of cough with sputum and pain in the chest in a man of or beyond middle age. If the sputum is blood-streaked the suspicion must be stronger, but in the majority of cases it does not contain blood. If in addition to such clinical features there is also a demonstrable atelectasis of a lobe of the lung, the probability of a tumor of the bronchus becomes very much greater. Atelectasis implies the presence of a bronchial obstruction, and the most likely obstructing agent in a person of middle age is a tumor, since foreign bodies are rare except in children. If, however, there is a long history of pulmonary inflammation there is a possibility that the obstructing factor may be a benign stricture rather than a tumor. Cases of acute atelectasis, "massive collapse," which occur as a postoperative complication and sometimes in certain serious acute diseases, are not likely to cause confusion. Atelectasis then becomes a matter of major importance and every patient with a demonstrable chronic atelectasis of a lobe should be suspected of possibly having a bronchogenic carcinoma. Even the presence of proved pulmonary tuberculosis does not necessarily exclude the possibility of a primary carcinoma of the lung because occasionally the two conditions are coexistent. Some of the older writers considered that the chief etiological factor is tuberculosis, although it seems doubtful to me that such is the case. Atelectasis of a lobe is usually easy to recognize by roentgenological examination, as you are well aware. It is important, therefore, that roentgenologists should take into consideration the possibly serious implications which a chronic atelectasis may have.

While on the subject of atelectasis it seems hardly necessary to state that, at least in early carcinomas of the lung, the size of the shadow on the roentgenogram is not necessarily proportional at all to the size of the tumor. A very small tumor which completely obstructs a large bronchus may create a complete lobar atelectasis. What one observes, therefore, on the roentgenogram in such a case is not the shadow of the tumor but of the atelectatic lung. On several occasions my attention has been directed to this mistake by the fact that, al-

though a correct diagnosis of primary carcinoma of the lung has been made elsewhere, an inexperienced roentgenologist has interpreted the opacity caused by the atelectasis as being the outline of the tumor.

I have presented certain classical features which when present together almost establish the diagnosis except for the confirmation by a bronchoscopic examination. Unfortunately, not all cases by any means present this classical picture. Some tumors do not obstruct a bronchus and therefore do not induce a large amount of atelectasis. Again, in many cases, in fact in the majority which we see at St. Louis, various complicating factors are so conspicuous that they may tend to overshadow the most important lesion itself, namely, the carcinoma. These complications consist of the manifold lesions induced by pulmonary and pleural inflammation, such as multiple abscesses, bronchiectasis, pleural effusion or empyema, etc., the diagnosis of which need not be discussed here. Moreover, it is not always possible to establish the diagnosis of a bronchogenic carcinoma by a single bronchoscopic examination, and often repeated examinations are necessary.

In many cases other diagnostic methods are helpful, such as the use of lipiodol which sometimes serves to reveal the presence and the site of a bronchial obstruction, the presence of an associated bronchiectasis, etc. Sometimes in this way a tumor may be recognized which is not bronchogenic but which nevertheless is causing an atelectasis by outside pressure against the wall of the bronchus. The distortion of the whole bronchial tree by the tumor may thus be observed. Artificial pneumothorax is sometimes of great assistance in the roentgenologic recognition of at least the atelectatic portion of the lung. If any pleural fluid is present the examination of it by Mandlebaum's method is often of the greatest help, especially if there are pleural metastases. This consists of centrifugalizing the removed fluid, fixing the sediment in formalin and sectioning and staining it like any other tissue to be examined microscopically. In several doubtful cases we have established the diagnosis by the use of this method. Occasionally also we have found it necessary to resort to exploratory thoracotomy, or at least to the use of the thoracoscope.

TREATMENT

Only two possibilities exist for the treatment, of which one is radiotherapy (either by roentgen rays or radium) and the other is excision. Symptomatic treatment and sometimes even surgical attack on the complicating lesions, such as empyema and pulmonary abscess, often afford some degree of palliation. Likewise the opening up of a stenosed bronchial lumen by the use of the bronchoscope will often permit aeration of an atelectatic lung and thereby result in marked temporary relief of some of the patient's symptoms. I prefer, however, not to discuss here at any length the palliative treatment because it seems to be of greater importance to devote the time to a discussion of the hopeful aspects and the possibility of obtaining a clinical cure of this condition which is too often regarded as hopeless.

The discussion will, therefore, first be directed to the use of radiotherapy. It is a matter of the utmost importance that the question should be definitely settled whether or not treatment by either the roentgen ray or by radium has ever cured a single proved case of a primary carcinoma of the bronchus or lung. Probably the majority of my audience will be astonished at my raising such a question because the literature contains several references, to say nothing of many more loose statements, concerning cases which are supposed to have been cured. So far as I have been able to find, however, none of the reported cases has so far met the rigid requirements which we demand for the acceptance of a probable cure of cancer in other parts of the body. Perhaps this is because the modern treatment of this type of cancer by radiotherapy is too recent to have permitted an interval of five or six years to elapse between the beginning of the treatment and the time of

reporting the case. Again in some of the cases which have been reported the pathological evidence is not of a kind which can withstand a rigid scrutiny. It is well known, for example, that in bronchiectasis the epithelium of the bronchi frequently undergoes a metaplasia and hyperplasia. An inexperienced pathologist might occasionally mistake a small fragment of tissue removed through the bronchoscope for a carcinoma when actually the lesion is not malignant. One serious objection to accepting a case as cured after only three or four years is the well-known fact that the duration of life in this condition is extremely variable. It is by no means exceptional to have a patient live and even to carry on some of his normal activities for several years after a positive diagnosis has been made, especially if he happens to have an extensive atelectasis which is relieved from time to time by bronchoscopic examination and dilatation of the lumen of his bronchus. We have seen this occurrence on several occasions. It would be unnecessarily time consuming to enter into a critical discussion of the reported cases. I wish also not to be misunderstood as denying the possibility of the efficacy of radiotherapy in occasional cases. I am merely protesting against what seems to be the rather general acceptance at this time by certain radiologists that a reasonable degree of hope of a cure of a primary bronchial carcinoma by radiotherapy can be given to a patient afflicted with this serious disease. It is possible of course that further study will show that certain types of these tumors are more radiosensitive than others. Over against the optimistic statements which have been made by some radiologists can be placed the conclusions reached by those who in spite of an extensive experience have found no benefit whatever to result from treatment either by radium or deep roentgen therapy. I refer especially to Sauerbruch and Nissen, Maxwell and Nicholson, and Edwards. Moreover, 19 patients of our own, not included in the 26 autopsy cases already referred to, were treated by Dr. Sherwood Moore and his staff with deep roentgen therapy and lived on an average only five months after the treatment was started. No beneficial effect of any kind was observed. Even most of the radiologists who have written on the subject admit the refractoriness of this particular cancer to radiotherapy. One can therefore infer that only in the exceptional case can a favorable result be expected, if at all. Radiologists have often become optimistic about the beneficial effects of radiotherapy because they have noted what seemed to them to be a diminution in the size of the tumor. In most of the published cases, however, it is apparent that what has been interpreted as a diminution of the tumor has really been only a diminution of the shadow of the atelectatic portion of lung. Since changes in the amount of atelectasis often occur spontaneously, and particularly if the patient has had bronchoscopic treatments, it is a mistake to infer that the radiotherapy used has been effective in reducing the size of the tumor merely on this evidence. Finally, in proceeding from a discussion of radiotherapy to other forms of treatment, I wish to make a plea that in order to determine whether or not radiotherapy is effective the future reports of the treatment of cases by this means should be made in such a way as to make the evidence incontrovertible.

Those of you in the audience who perhaps have been somewhat irritated by my criticisms of radiotherapy for this condition and by my unwillingness to admit any so far demonstrated successful results over a five or six year period, have probably been asking yourselves (and would like to ask me) what other method has shown any better results. Unfortunately, I cannot cite any statistics of cases which up to the present time do show much better results when gauged by the standard of five or six years' freedom from recurrence. However, since by training and occupation I am a surgeon, it is only natural that I should favor the idea that better results might be expected if the entire growth could be widely removed together with the regional lymphatic

vessels and glands. It is commonly agreed, I believe, except perhaps by the most enthusiastic radiotherapists, that in dealing with cancer in most locations better results are obtained if the growth is removed surgically and the radiotherapy is used merely as an additional aid.

Let us then proceed to a discussion of what has actually been accomplished by a direct surgical attack upon the growth. The simplest procedure would obviously be the removal through the bronchoscope. Carlson and Ballon list six instances in which the bronchoscopic removal of a primary malignant bronchial tumor has been attempted. From the information available, however, there is only one case in which the likelihood of a clinical cure can be considered as having occurred. This concerns a patient with a pedunculated endothelioma who was alive and well eleven years after Jackson had removed the tumor through the bronchoscope. Some doubt, however, must be expressed about the malignancy of this tumor since the patient had had symptoms for five years before its removal. Arbuckle's case is of unusual interest in that the patient, himself a physician, did not die until four years and two months after the bronchoscopic removal and cauterization of a carcinoma which had given symptoms for about three months before the operation. Two courses of deep roentgen therapy were also used. During much of the postoperative period the patient was able to carry on his medical practice. Although occasionally an early polypoid carcinoma may be successfully removed by the bronchoscope, it seems unlikely to me that much can be expected from this treatment because in nearly all cases it would be impossible to remove the growth completely.

A far more satisfactory method of removing the tumor would theoretically be by a wide dissection which would enable the surgeon to get well around the growth and at the same time to remove those lymphatic vessels and glands which are most likely to be involved. This can be accomplished only by opening the thorax. In all there are apparently six cases in the literature in which a patient has survived for at least a year the surgical removal of the carcinoma. Two of these patients were operated on by Sauerbruch, one by Churchill,* two by Edwards and one by Allen and Smith. At the time of the publication of these respective reports one of these patients was still alive and well five years after the operation, another one three years, and two for two years. In most of these cases one lobe of the lung was removed.

I have recently, April 5, 1933, successfully removed the entire left lung at one stage because of a carcinoma which, although it arose in the bronchus of the left upper lobe, occupied such a position that it would have been impossible to save the bronchus of the lower lobe if a satisfactory amount of tissue had been removed proximal to the carcinoma.† This happens to be apparently the first case in which an entire lung has been removed for a carcinoma and the first case in which it has been removed successfully in one stage for any cause, although both Nissen of Berlin and Haight of Ann Arbor have each successfully removed a whole lung for bronchiectasis by allowing it to slough out after ligation of the hilus. Although it was originally my intention to perform only a lobectomy and although the exigencies of the situation were the reasons for changing the plan to the removal of the whole lung, various subsequent features make it seem probable that this operation may have advantages over a lobectomy for malignant disease, at least in certain cases. Not only does one have a greater opportunity to get well around the tumor but the opportunity is also presented to remove the mediastinal lymph glands which receive the drainage from the affected lung. Indeed in the case under consideration I was able to remove those glands. Although an interval of only about six months has elapsed since the operation,

* A later report of this case received in a personal communication from Dr. Churchill nearly two years after the operation stated that the patient showed no evidence of recurrence.

† The details of this case with illustrations of the pathological material have recently been published.[6]

which is obviously too short a time to permit one to be very optimistic about the final result, there are nevertheless several encouraging features. The tumor, which was a squamous cell carcinoma, was only about 1 cm. in length and was confined to the site of its origin in the bronchus. No evidence of metastases could be found in the lung tissue or in the mediastinal glands which were removed. Moreover, the carcinoma had not penetrated the cartilage of the bronchial wall, a feature which, by analogy with what is well known concerning carcinoma of the larynx, should be of good prognostic significance. A letter about a week ago from the patient, who is an obstetrician, states that he has gained 16 pounds since the operation, that he drives his car and expects to begin his obstetrical practice again in another month. His wound has been solidly healed for more than four months.*

Although it is unsafe to indulge in predictions it seems, as nearly as one can tell from the evidence, as if all of the cancer tissue had been removed in this case including the lymphatics, which would have received the first metastatic deposits if any had taken place. By analogy with what is well known concerning a similar radical operation for carcinoma of the breast when the lesion is confined to the mammary gland, the chance of freedom from recurrence should be better than 60 per cent. Would radiotherapy alone have offered the same chance? The evidence is all very much in the negative. Granted that the operation of total removal of the lung and of the regional lymphatics is a severe one which will probably necessarily have a high mortality percentage, should that fact be a deterrent in advising it in properly selected cases? It seems to me that we are justified in advising it if by doing so we can save only 15 or 20 per cent of those who have this dreaded condition. For after all, one who dies from the operation is probably spared months or years of suffering.

If, however, we are to get good results by operating on these patients, it is essential that we should have the opportunity to perform the operation before the condition becomes advanced. To those who perhaps have been convinced that radical surgery offers the best chance to patients with bronchogenic carcinoma, I would suggest the necessity of the establishment of a prompt diagnosis by advising an early bronchoscopic examination and biopsy in any suspicious case, especially one of chronic atelectasis, and the desirability of an early radical operation. To those who still have the opinion that radiotherapy alone is superior to a combination of operation and radiotherapy, I should like to suggest the same necessity of a positive diagnosis by biopsy in any suspicious case and, furthermore, that at some future date, perhaps in 1938 or 1939, we compare notes on our results, possibly at some such congress as this, or at a joint meeting with the American Association for Thoracic Surgery.

* The patient was seen on October 10, a little more than six months after operation. He had no pulmonary symptoms and was steadily gaining in weight and strength. He thought he had no more dyspnea on exertion than a normal man of his age, and he was about ready to resume his practice as an obstetrician.

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EARLY EXPERIENCES IN RADIATION THERAPY

JANEWAY MEMORIAL LECTURE*

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IN THE history of radiation therapy the name of Dr. Henry H. Janeway must always be given a notable position. When he entered this field in 1910, radium was being cautiously employed in a few centers as a superficial application for the relief of some tumors of the skin and accessible mucous membranes, and with considerable success, but it had not been extended in a serious way to the control of any of the major forms of cancer. When he left the field at his death in 1921, it had been demonstrated that radium and roentgen rays were capable of curing a considerable proportion of many of the major forms of cancer. Substantial portions of this progress were directly due to his studies.

In 1910 Wickham and Degrais published the first comprehensive work on radium therapy, describing the methods of surface application and recording some excellent results with superficial cancers, mostly of the skin. While temporary healing of certain cancers of the mucous membranes was reported it is evident that the dosages employed were quite incapable of dealing successfully with these infiltrating and metastasizing processes. Yet it is probable that Abbe in America, Wickham in France and others, were obtaining occasional cures of these types of cancer in a few early cases.

Abbe began the use of radium in 1903 and apparently cured some cases of basal cell epithelioma of the skin. In 1910 he reported the cure of several cases of giant cell tumors of bone, but admitted that he had never cured a case of carcinoma of the lip.

Between 1910 and 1914 there was a rapid extension of the interest in all forms of radiation therapy, especially in Germany and France. By 1914 the large proportion of recurrences forced recognition of the fact that previous dosages were inadequate for all but superficial growths. This fact proved most disconcerting, and I well remember my own feeling of amazement and incredulity upon finding that a tumor process once caused to regress and apparently disappear could start to grow again from the remnants of damaged cells. But they did.

Kelly and Burnam[1] began the systematic treatment of uterine cancer in 1912 and reported their first results in 1915. Schmitz[2] recorded his early observations on uterine cancer in 1915. Clark[3] followed with an important communication in 1916, which had a marked influence on American practice. They all used moderate amounts of radium in the cervical canal.

After duplicating these results in a few favorable cases and encountering the bitter disappointment of prompt recurrence after surface healing followed by rapid dissemination, Janeway in 1915 attacked in earnest the problem of delivering adequate radiation to the infiltrating carcinomas of the mucous membranes. Within two years he was able to report the more or less successful treatment by radiation of twenty-two major forms of cancer.

It is of much interest and appropriate to this occasion to inquire into the personal characteristics and intellectual background of this remarkable man. Dr. Janeway was primarily a surgeon. In 1910 he was attending surgeon at the New York City Hospital where major surgical problems arose in profusion and where considerable freedom existed in dealing with them. Here he became adept in the use of the esophagoscope, bronchoscope and gastroscope, and

* Delivered before the American Radium Society during the American Congress of Radiology, Chicago, Ill., Sept. 25–30, 1933.

he designed a new and superior gastroscope which was made by Wappler. He was particularly skillful in examining the gastric mucous membrane by the gastroscope and in removing pieces of tissue for microscopic diagnosis. I have a record of nine successful diagnoses of gastric cancer made by him by this method. In 1914 he perfected a method of gastrostomy which provided a mucous membrane lined tract instead of one lined by granulation tissue. He conducted quite extensive clinical and experimental investigations into the nature of shock and I believe added important contributions to the knowledge of circulatory disturbances in this condition. His work in intratracheal anesthesia with Green attracted much favorable attention.

An early and important laboratory study related to the origin, structure, and course of a remarkable group of multiple carcinomas of the skin, in which he showed that the beginnings of the carcinomatous change in the epidermis were associated with local hyperemia and capillary dilatations in the regions of the multiple tumors. This study was published in the *Zeitschrift für Krebsforschung*, 1910, but has never received the attention it deserves. It was based on the examination of about 600 sections taken from a considerable group of clinical cases. It was this work which first brought me in contact with Dr. Janeway and gave me the impression that he possessed unusual ability as an observer and investigator.

Throughout all his earlier activities in medicine Dr. Janeway displayed the spirit of a scientific investigator. He acquired a broad grasp of medical problems but his general attitude was that most things that were being done could be done better in some other way. Therefore it is not a matter of surprise that his originality was sometimes mistaken for eccentricity and that he found some difficulty in securing immediate recognition in surgical circles. This situation made him available for the new field in cancer study which opened up when radiation therapy made its advent and called for radical changes in the orthodox surgical attitude toward this group of diseases.

Dr. Janeway's entire professional life was beclouded and burdened by a grave physical infirmity, a cystic adamantinoma of the mandible, which first appeared in 1905, was operated on many times, persistently recurred, eventually extended and finally caused his death in 1927. He was always deeply concerned about his physical condition, and during the last several years of his life he battled continuously with successive operations, efforts at control of the disease by each succeeding method of radiation, with several extremely painful complications, including major attacks of facial neuralgia, and finally with infection and cerebral manifestations. During all these gruelling years his amazing courage enabled him to find long hours for work which with indefatigable industry he applied to the solution of tasks set before him.

There is no doubt that the handicaps of his heroic fight against incurable disease colored his activities, stimulated the energy with which he approached all his problems, accounted for some of his radicalism, and nourished his strong hope that a cure for cancer must be provided, and indeed was just within reach.

When Janeway took charge of the department of cancer surgery and radiation therapy at the Memorial Hospital in 1912, he at once realized that he was dealing with powerful and dangerous agents which could be controlled only by a knowledge of their physical properties. Of this knowledge he had none, but instead of starting out in an empirical way he acquired this knowledge by night courses of study at Columbia University, extending over a period of about two years. How he found the time it was difficult to see, but his example is worthy of emulation. Thus the qualities which led to his success were scientific imagination, indomitable will and untiring industry, excellent surgical training, and a strong confidence in the ultimate capacity of radiation to control cancer.

In 1910 the need for more intense irradiation for resistant tumors was fully recognized but the means of providing it were not available. Surface applications of radium healed over many a superficial tumor which soon recurred, and repeated applications were followed by ulceration and local or general dissemination. Tumors beneath the skin gave merely a temporary regression or none. The field of radiation therapy seemed to be strictly limited to superficial tumors. Efforts to increase the dose led to disastrous results, with much destruction of tissue, prolonged and painful ulceration and eventual recurrence.

At this point therapeutic efforts began to diverge along two different lines. Some observers used repeated applications of lightly filtered radium over a considerable period. The results improved but the deep tumors and the extensions of superficial tumors failed to respond. Others began to insert tubes of radium within the tumor, often employing surgery to expose the tumor. In this way very large and adequate doses could be reached without much local or general reaction and any accessible or resistant tumor could be treated. Even caustic doses could be employed without danger. Radium proved to be a very superior caustic for cancer since the selective action at a distance sterilizes a wide area.

Stevenson[4] of Dublin was apparently the first to report on the successful use of interstitial irradiation, in a case of cancer of the tonsil in which he inserted a silver tube containing radium. One of Janeway's first cases was an adenocarcinoma of the parotid through an incision into which he inserted a silver tube containing 8 mg. of radium allowed to remain forty hours, four hours each day at weekly intervals. The tumor regressed completely and the patient recovered but after a long period of ulceration. The idea of using capillary glass seeds containing radon was conceived by Duane working with Janeway who developed this method extensively and with much success in a large variety of superficial and deep tumors. It greatly widened the field of radiation therapy and for the first time accomplished the cure of a substantial proportion of resistant carcinomas of the mucous membranes. I believe that the first cures of any considerable number of carcinomas of lip, tongue, tonsil, etc., were secured by Janeway by this method.

The sensational character of this advance can hardly be realized by one who had not lived through the trying period when superficial healing of squamous carcinomas was regularly followed by recurrence and death. To Janeway it seemed to be the beginning of the end of the problem for all superficial and many deep tumors. By common consent of his colleagues, but not without grave misgivings by conservative surgical friends, all cases of carcinoma of lip, tongue, tonsil, skin, in his service were immediately assigned to radiation therapy, a decision fully justified by subsequent experience. The radical nature of this step may be revealed by the fact that the first cases of lip cancer treated by interstitial irradiation were done surreptitiously and the cases were exhibited only after all traces of the disease had disappeared, and all protests were throttled.

Janeway carried the use of glass seeds far beyond the superficial tumors. He used them with considerable success in the cervix uteri, rectum, tonsil, esophagus, breast, and in the lymph nodes. Since the glass seeds have now been discarded I take this opportunity of calling attention to some of their advantages which are not possessed by any other method. The glass seeds allowed the passage of much beta radiation so that their action was highly caustic. The tissue reaction excited was quite severe, often painful, but very efficient, and the acute inflammatory process was followed by extensive cicatrization. If the patient could stand the ordeal he was often rewarded by an unexpected cure of extensive disease. I recall a case of extensive but doubtless localized cancer of the rectum in which Janeway inserted many glass seeds. The patient suffered severe pain and distress and left the hospital in disgust and

would not return, but two years later she presented herself without any trace of the disease. He treated inoperable breast cancer by many glass seeds in breast and axilla, and secured a remarkable degree of sterilization of wide areas of cancer tissue with very marked cicatricial contraction of the whole area. I believe the sterilization was more complete than that now usually accomplished in most cases by other methods, in that as a rule no traces of cancer cells could be found. The superiority of glass seeds in the breast depends on the severity of the reaction excited, which in fat tissue must be very severe in order to accomplish the destruction of all cancer cells. This peculiarity might well be kept in mind by those who are using gold seeds or platinum needles and not infrequently failing to get complete sterilization.

On account of the severe and painful reaction produced by glass seeds they have been replaced by gold seeds, the greater filtration of which cuts down necrosis and inflammatory reaction. But it must not be assumed that gold seeds do not produce necrosis. In most instances there is a narrow line of necrosis about the gold seed, and not infrequently infection and a wider zone of necrosis is observed. These results together with the reaction about a permanently placed foreign body and the difficulty of uniform placement of the seeds leaves certain important advantages with removable needles. Janeway recognized this fact and made considerable use of steel and platinum needles.

An important instrument with which Janeway made many pioneer observations was the radium pack. On the whole, one looks back with considerable disappointment at the early results obtained with this most capable method of delivering deep radiation. While excellent results were early secured with the radiosensitive tumors, the primary regressions were not followed up and the ideas of growth restraint, or of tumor destruction by divided doses, were not seriously entertained. Those were the days of the fixed carcinoma dose or sarcoma dose which had to be given as quickly as possible, the patient to bear the consequences, which all too often were disastrous. The theory that the curative result depends exclusively upon the direct effects of the rays upon tumor cells dominated the minds of radiologists. Hence if a moderate dose was not successful the indications were to double or quadruple the dose. Accordingly much destruction of tissue often followed the higher dosage, the patients were made very ill, and the late consequences of progressive arteritis gave shocking proof that there is a limit to the amount of radiation that may safely be given in a brief time.

Yet Janeway had the satisfaction of seeing many of the very first astonishing results from deep radiation therapy by the radium pack on sensitive tumors, including thymic tumors, embryonal carcinomas of testis and ovary, metastatic mammary carcinoma in the bones, lymphosarcoma of chest and abdomen, mycosis fungoides, myoma of the uterus, and various metastatic tumors in the lungs. One of his most spectacular results was a case of cellular tumor of the spine with complete paraplegia in a pregnant woman. The paraplegia completely cleared up and the patient went to term, but a year later the disease recurred and proved fatal. The limitations of the radium pack as used at that time also became apparent. It proved impossible to bring about a complete and permanent cure of many cases showing an impressive primary regression, the practical difficulties of continuing the treatment were serious obstacles, and the idea of prolonged repeated dosage or of subsequent interstitial radiation were not pursued. Many bad results with extensive late necrosis also marked the early experience with the radium pack, especially with squamous and other resistant carcinomas.

A great deal of effort was early devoted to the treatment of carcinoma of the esophagus, larynx, and rectum by silver filtered radium, inserted in the lumen of the organ. Beginning, unfortunately, with ex-

cessive doses, the results were generally unsatisfactory or disastrous. Perforations of the esophagus were as frequent as any palliative results. The larynx cases did better but serious stenosis followed in some of those in which the disease was controlled. In the rectum the strong surface applications were extremely painful and not effective in the deeper tissues. This method has been largely abandoned but we are now possibly going to the other extreme and attempting to accomplish the same result by external irradiation alone. Yet there were some cures from the silver tubes and the question arises whether in the treatment of carcinoma of the esophagus, larynx and rectum, the work might not be divided between internal surface irradiation and external irradiation by roentgen rays, thus reducing the risk of damage by both.

By 1920, by ingenious combinations of silver filtered tubes, glass seeds, and cross firing from larger amounts of radium in platinum needles, Janeway was able to record some remarkable cures of tongue, tonsil, antrum, nares, larynx, and rectum. In accomplishing these results, which were generally in advanced cases, he had to rely heavily upon the combination of surgery with irradiation, first to expose the tumor for accurate irradiation, to remove necrotic tissue, and to follow up the initial result with repeated applications. This work opened up the new and difficult field of radiation surgery. One of his earliest results was one of the best I have ever seen. It was a case of cancer of the tonsil with extensions to the cervical lymph nodes, and wholly beyond the reach of surgery alone. Into the tonsil he inserted glass seeds and into the neck he placed platinum needles producing a severe inflammatory reaction in both areas which lasted for some weeks. The tonsil cleared up completely but the nodes remained and after some months he dissected out the nodes and placed more glass seeds in the excavated bed. There followed another severe period of inflammatory reaction and general intoxication with multiple rheumatic manifestations in the joints, but the tumor never recurred, the patient regained his health and has remained well with little scarring. Here the disturbing factor was infection.

Stimulated by such observations, Janeway initiated the plan of conservative treatment of the regional lymph nodes in carcinoma of the mucous membranes, and in cooperation with Quick carried it out consistently and with constantly improving results. First, he noted the marked response of lymph nodes in many cases to ordinary doses of external irradiation, then the greater response when the doses reached the limit of skin tolerance, next the control of metastatic cancer nodes implanted with radium seeds, and finally the value of implanting the bed of excised nodes with seeds. Needless block dissections were thus avoided.

Probably the most important field in which Janeway was able to break new ground was in uterine cancer, both of the cervix and the fundus. There had been some reports of cures of cervical cancer before 1914 but no clear description of a method which could be relied upon. He began with the silver tube in the cervical canal and by giving superficially caustic doses was able to control some early cases and to obtain unexpected palliation in many advanced cases which then formed the bulk of a very unfavorable material.

In this material all stages of the destruction or removal of squamous carcinoma of the cervix were demonstrated in serial biopsies under the microscope. Here also by 1916 the conclusion was reached that the radiation cure of cancer depended very largely on the peculiar inflammatory reaction excited and not so much on the direct action on the tumor cells. At first there were many warning voices against leaving the uterus in the body in apparently cured cases of cervical cancer. Although he was a skillful surgeon Janeway himself never extirpated the uterus in such cases but for about two years he had abundant opportunity of seeing disastrous results from hysterectomy performed im-

mediately after, or at increasing intervals after irradiation. There was also and for the same reason abundant opportunity to demonstrate the anatomical cure of cervical cancer by radium, which for a long time was insisted upon as the crucial evidence of cure.

Many early cases recurring after intrauterine irradiation, the next step was the combination with glass seeds in the tumor and cervical tissue. This method caused not only rapid breaking down of bulky tumors and excavation of widely involved cervices, but it also led to infection, parametritis, sloughing fistulas and even peritonitis and soon came to be regarded as a hazardous resort. It demonstrated the dire results of too aggressive efforts to kill cancer cells. It was soon replaced by the use of intravaginal applications of heavily filtered radium, which Janeway used with success and which Harold Bailey later improved in the form of the 2-gram vaginal bomb.

The early results with cervical cancer suffered from the lack of correct gynecological approach to the problem. Enthusiasm for curing advanced cancer and apparent necessity led to the treatment of very late cases. Many fistulas attributed to irradiation were merely the result of breaking down of widely infiltrated areas of cancer. Progressive infection was a serious complication and the idea of spending a few days in clearing up an infected cervix before irradiation did not receive the attention demanded. It was assumed that the radium could not affect cancer cells beyond 1 or 2, or later 3 or 4 centimeters, the distances permitted increasing with the dosage. More confidence in the distant effects of the vaginal applications was provided when in an autopsied case destructive effects on cancer cells located in the iliac pelvic nodes were clearly demonstrated. All these experiences made in much haste but fully appreciated seem a necessary background for the present more deliberate and conservative plan of properly preparing the patient and the tumor for irradiation, and preceding the local treatment by a full cycle of external irradiation.

The radiation treatment of fundus cancer presented few contraindications to Janeway. He rightly conceived that if the tumor was not bulky it was probably superficial and vulnerable to the caustic doses of radium then used in the cervix. His success with this disease almost equalled that with the cervix but he never ventured to use the higher doses which it is now known may be employed in the fundus. Some of his first cases recurred after two to five years with hemorrhage and it was very interesting to find the remnants of partly devitalized fundus cancer remaining in the uterus but quiescent and giving few symptoms. When this service was turned over to his successor he had records of a substantial list of three-year cures of fundus cancer.

During all the early development of radium therapy, all workers were constantly occupied with the task of devising suitable apparatus for applying the radium in its different forms. Much ingenuity had to be exercised in this work. There was no standard apparatus on the market. In this field Janeway was extremely industrious and resourceful. He brought out the dental modelling compound as a very adaptable material for accurately applying radium tubes to various lesions. He devised many special operations for rendering tumors accessible. He was particularly skillful and foresighted in exposing the antrum for carcinoma of the maxilla and he had some early remarkable cures of advanced cancer in this region. He applied radium to the esophagus by the sound, and he opened the stomach and applied tubes and seeds to esophageal and cardiac and gastric cancer. He used the active deposit of radium on platinum plaques for the treatment of vernal catarrh, succeeding in curing many of these refractory cases but at the expense of cataract. He injected a solution of radium deposit in salt solution into the circulation and brought about striking re-

missions in the leucemic process, but the effective doses proved toxic and this method did not establish itself. Yet it appears not impossible that in small doses it may be a valuable adjuvant to external irradiation. Maisin is now injecting Hocking's fluid, a solution of thorium uranium oxide, into the blood and thinks the results of external irradiation are definitely improved. For about two years the colloidal solution of the heavy metals, copper, arsenic, mercury, and bismuth, were extensively employed, both with the hope of curing cancer and of intensifying the action of roentgen rays. After a very extensive labor this field of endeavor was abandoned without definite results. I believe the failure depends on the lack of any tendency of the heavy metals to be taken up by tumor tissue. They seem to prefer the liver and the bones. The modern use of colloidal lead as a cure for cancer seems to be having much difficulty in overcoming this fundamental deficiency. Local heat was early employed as an adjuvant to radiation, probably first by de Keating-Hart in Paris. Theoretically it should be effective, but in practice Janeway, who was much interested in this matter, soon found that heat caused pain and hemorrhage, external and internal, often uncontrollable, and the treatment was therefore abandoned. Possibly lesser grades of heat in less vascular tumors may give better results.

The early workers had to rely chiefly upon clinical observation, trial and error, in determining the comparative effects of different filters, distances, and times of application. Yet it was obvious that methods could not be standardized or results repeated unless the amount of energy actually reaching the tumor was calculated by physical measurements or estimated by repeated experiments. In conjunction with his laboratory colleagues Janeway devoted much time and thought in formulating the problems and assisting in their solution. He devised and conducted many experiments on lower animals, dogs, cats, rabbits, rats, placing radium in or on the stomach, kidney, intestine, thyroid, brain, and observing the immediate and late effects. His early contributions were largely concerned with these studies and his therapeutic efforts were constantly influenced by them.

The period from 1910 to 1920 was one of definite but rather hesitating progress in roentgen therapy. Attention was mainly centered upon radium as a curative agent in cancer and there was little conception of the possibilities in roentgen therapy. Roentgenologists who engaged in therapy were looked upon with suspicion. It was difficult to enlist the interest of any established roentgenologist in this questionable field. Into this breach Janeway placed himself with interest and some confidence based on his thorough training in the physics of roentgen rays. The apparatus available at that time consisted of the Müller tube delivering about 100 to 120 kv. The principles of filtration presented quite different problems from those of radium filtration, and had to be worked out empirically. It was soon found that with light filtration with aluminum many good results were obtainable with superficial tumors. Short exposures with unfiltered roentgen rays were also employed. The sharp reactions produced by soft roentgen rays rendered them hazardous agents in cancer therapy, but the nature of the hazards was at first quite unsuspected. Not until many months elapsed did the late telangiectases and ulcerations make their appearance and then too late to save many patients from these unfortunate sequelae. Reports of serious injuries produced by soft roentgen rays began to appear from many sources, causing a sharp reaction against their use, and particularly against unfiltered radiation. At the same time the very late results of roentgen-ray dermatitis and cancer in roentgen workers began to appear in numbers and a strong distrust of the value of soft radiation was established.

Much confusion arose from the multiplication of terms, the conflict of theories, and the striking differences in the effects

of different doses. There was the stimulating dose, the epilation dose, the erythema dose, the vesicating dose, and all too often the necrotizing dose. Duplication of effects proved uncertain because inadequate attention was paid to the calibration of machines and the means of estimating the output were unreliable. One observer would claim that a certain dose would make hair grow while another found that same set-up would destroy the hair. All the medical specialties grasped at the new agent because of its alleged capacity to favorably affect all manner of chronic infectious and inflammatory as well as neoplastic processes. The beauty specialist removed moles, freckles, keratoses, hairs, and warts, and contributed a large share of the damaging late results of soft radiation. The dermatologist employed it rather indiscriminately to eczema, sycosis, mycosis, ringworm, corns, hyperidrosis, acne, boils, and a great variety of minor cutaneous conditions. In cancer the atmosphere of roentgen therapy was quite obnoxious to conservative minds. The noisy racket of the transformer, the noxious gases exhaled from the tubes in ill ventilated rooms, and the retching of nauseated patients, created a repulsive contrast to the solemn ceremonies of the surgical amphitheater.

The constant renewal of broken tubes and frequent replacement of old by better designed machines encouraged the adoption of exaggerated charges by roentgen therapists, a fault which seems still to cling to radiation therapy. While the degrees of radiosensitivity of tumors were gradually emerging and carefully considered, the varying response of different organs and tissues of the body were only vaguely surmised. At one period the prescription of dosage was so uncertain and the results apparently so capricious that all one could really do was to place the patient under the machine and hope for the best. Patients were often burned from unexpected leaks and on one or more occasions, it is said, they were actually electrocuted on the treatment table. If roentgen therapy had not possessed a sound foundation it would have been sunk under the burden of its many adherents.

But soft roentgen rays did not produce very definite effects which, with the improvement in technique, became controllable. These effects consisted of degeneration of capillary walls with hemorrhage, destruction of tissue cells, exudation of serum and leucocytes, followed by a prolonged reparative process with cicatrization, and leading eventually to chronic progressive changes such as telangiectasis, fibrosis, and necrosis, if the dose were too heavy. It was highly destructive to tumor cells and proved very effective in destroying cells actually reached by the rays. It was early noted to be more destructive but less selective than comparable doses of filtered radium. Hence it was very effective in dealing with superficial tumors and very disappointing in failing to reach the deeper portions of such tumors. This contrast was well illustrated in breast cancer, for the superficial nodules in the skin would disappear while the deeper portions proved strangely unresponsive. A great deal of time and effort was wasted and much damage done in the attempt to cure sizable tumors with low voltage roentgen rays.

From these overzealous efforts warnings arose against the dangers of fibrosis of the lungs, interstitial myocarditis, ulcerative enteritis, degeneration of adrenals, acute nephritis and even secondary cancer, all of which appear to have resulted with more or less frequency as the penalty of overdosage.

Out of this situation gradually emerged the principle that the higher the voltage and the greater the filtration, the better were the deep effects. No one who can compare the abortive results of the early efforts with soft roentgen rays with the present accomplishments of high voltage, with heavy filtration delivered in divided doses can doubt the validity of this principle. Whether or not this principle can be carried on indefinitely is quite another matter. The construction of very high volt-

age machines involves engineering difficulties which have not yet been overcome. Be that as it may, the advance into the use of higher voltages, frequent calibration and increasing standardization of methods rescued roentgen therapy from imminent disrepute.

RÉSUMÉ

Comparing the present status with the conditions existing in the early days everyone must admit that the progress of radiotherapy has been very rapid and substantial. The early workers moved largely in the dark. They were constantly encountering unexpected and unaccountable variations in results, eccentricities in behavior of apparently identical tumors and patients, and all too often unfavorable primary results or unfortunate late sequelae. No one who passed through that period would wish to repeat the experience. For several years there was a rather general feeling of apprehension that the whole theory of this form of physical therapy was unsound and would eventually have to be abandoned or restricted to a very limited field in dermatology. We owe a great debt to those pioneer workers whose scientific vision, resourcefulness, and optimism led them to persist until the initial difficulties were slowly overcome.

The advances have come, *first*, in the field of engineering, by which have been constructed more powerful, reliable and durable apparatus, and the provision of this apparatus on a wide scale. Water-cooled roentgen-ray machines delivering 200 kv. are now widely available, and we are encouraged to look forward to the use of very much higher voltages, without attempting to predict that they will give very much better results. We have now at our disposal a considerable variety of instruments designed to deliver roentgen rays for various purposes and are thus able to choose the one which experience shows is best adapted to a particular case. The exercise of clinical judgment is thus not restricted but encouraged. Radium is now available in much more liberal amounts and an appreciation of its highly selective effects has withstood the closest scrutiny. The methods of its application have now settled down to a well adjusted but not too confident or routine standard.

Second, we now know rather accurately what these machines and radium packs will actually deliver to the skin, and to every level of depth in the body and are thus able to prescribe dosage with assurance. Sufficient experience has now accumulated to enable us to know about what these doses will do to many different tumors as well as to the normal organs. We are now engaged in determining the best methods of delivering an effective dose in the physiological sense and this formidable and complicated task seems likely to occupy radiologists for some time to come.

Finally, most important and essential progress has come in a better understanding of the nature of the diseases to be treated by radiation, especially cancer. Knowledge of grades of malignancy and degrees of radiosensitivity of tumors are now recognized as essential part of the equipment of radiotherapists, so far as that information is available. Not a little of this knowledge is the direct result of observation upon the curious behavior of tumors under treatment. New varieties of tumors have been recognized and new classifications and subdivisions have been created which would probably never have been demanded or accomplished under the strictly surgical approach to the subject. Radiology has played a prominent rôle in the renaissance of cancer research during the past thirty years.

Yet the problems which still await solution are very similar to those that presented themselves at the beginning. Physicists are still aiming to devise and construct instruments which will deliver much higher voltages. Experiments are now under way dealing with voltages well into the millions. Observations on cathode rays have revealed some remarkable properties of this form of energy which may possibly

have an application to the treatment of cancer. There are indications that it may be possible to raise the temperature of deep-lying tissue by means of selective radiowaves, and thus intensify the effects of radiation. Sound waves under certain conditions have a destructive effect on living organisms and it is possible that this field of investigation may show results of interest to physiotherapy. Physics seems to have taken the lead away from chemistry in the realm of cancer treatment.

In the matter of dosage, the same old questions are constantly recurring. We have not yet settled the question of the relative value of maximum single dosage as compared with prolonged divided dosage. The limits of toleration of the normal tissues and organs still remain to be accurately determined. Disastrous and unexpected late sequelae of irradiation are still being encountered by experienced radiotherapists. Some of the newer techniques are approaching dangerously close to the limits of safety of normal tissues. Here a warning should be raised against the repetition of the disastrous results of overdosage, especially in young subjects, which were committed inadvertently by the pioneers, and which are now deliberately risked in some of the endeavors in intensive irradiation of malignant tumors. There is little justification in pursuing any radiological method which entails a high morbidity or substantial mortality. Much safer progress would seem to lie in the search for methods of locally intensifying the effects of ordinary doses.

In one respect the gratifying results of radiation therapy have distracted attention from some other lines of cancer research. In the old days the predominant interest was in the search for constitutional agents which might influence cancer, and reports on encouraging results from bacterial toxins, vaccination with tumor extracts, injections of alien proteins, serous exudates, heavy metals, cytolytic organic compounds, and immune sera followed one another in rapid succession. At present the activity in this field is rather desultory. It is claimed that radium is the best caustic for cancer, a claim that may prove to be wholly premature. The current absorption of interest in radiology emphasizes the serious responsibility which this branch of science is undertaking to carry, in this period of medical history.

Finally, we have still much to learn about cancer and the cancer cell. In few departments of this subject can the tumor pathologist sit back with satisfaction and contentment. In nearly every phase of this work questions daily arise which remain unanswered. There are still new varieties of tumors and new manifestations of well-known tumors which await recognition and analysis. The curious variations in the response of different subjects to cancer and to the curative effects of radiation remain highly obscure. The mechanism of action of radiation upon cancer tissue is still discussed in language which is highly abstract, philosophical and inconclusive. Perhaps a beam of light is beginning to appear in the modern study of the physiology of tumors, and it is not impossible that results of these studies may radically change the views and practices of radiologists. Who knows that the radiologist of the future may not be paying as much attention to the pituitary gland, the parathyroid, the adrenal, ovary and testis as to the actual tumors which seem to arise from disturbances of function of these organs? The whole subject of radiosensitivity requires reconsideration from the standpoint of the exact nature and physiology of the cells of origin. Much more detailed work has to be done before we can hope to explain the paradoxical regressions and recurrences of malignant tumors under radiation treatment. Great advantages are now enjoyed by the modern radiotherapist in the provision of modern equipment, the general advance in knowledge of his subject, and the endorsement of the public and other branches of the medical profession. American radiologists are in rather better position than in some other countries. With these advantages go

equal responsibilities of American radiology, in part payment of our debt to our pioneers, to aid and organize the attack upon the problems of the future.

In conclusion, I wish to express my appreciation of the honor of presenting this discourse, relating mainly to one of those American pioneers in radiologic science, my former colleague and esteemed friend, to commemorate whose life and work this lectureship is most appropriately founded.

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THE RELATION OF THE AMERICAN COLLEGE OF RADIOLOGY TO THE FUTURE OF RADIOLOGY*

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THE American College of Radiology has now rounded out its tenth year of existence. This offers a timely opportunity to briefly review its inception, its accomplishments, and its relation to the progress of present and future scientific radiology.

The idea of the College was conceived a great many years ago and was broached several times to my radiological friends of the old school. Some of these seemed impressed with the thought, but none appeared ready to take the initiative. Finally, to test out the idea, I sent personal letters to approximately one hundred active colleagues in the United States, with the result that an overwhelming majority signified their desire to form a college. Accordingly, the first and organizing meeting was held in San Francisco on June 26, 1923, and the College was duly created and incorporated under the laws of the State of California. Your attention is respectfully invited to the following salient extracts from the corporate document:

1. To create a fellowship among men of the medical profession who have distinguished themselves in the science of radiology, and who have made such contributions to said science as to warrant recognition.

2. To arrange for a Congress of Radiology, which shall consist of such scientific sessions, exhibits, demonstrations, and clinics as may be provided for and directed by the American College of Radiology through its Board of Chancellors, at such times and places as they may deem advisable.

3. To establish, maintain and conduct institutions of learning and research, to study into the subject of radiology and other sciences; to conduct health institutions, clinics and hospitals for the treatment of patients, for the promotion of health, physical training, social service, physical education and allied subjects, as authorized by law; to publish and distribute circulars, bulletins, magazines, books and other periodicals relative to such subjects, and to confer honorary and such other degrees upon its members as may be adopted by its by-laws.

4. To foster, protect and promote the general welfare and interests of persons engaged in said organization, and for the protection and encouragement of the medical profession, by combining against imposition, fraud and oppression therein and thereto.

5. To purchase, lease, option or otherwise acquire, to the extent allowed by law, and for the purposes herein enumerated, all the real and personal property, fixtures, equipment and apparatus of every kind necessary to effectuate and carry out the purposes of the corporation.

6. That its corporate business, property and powers shall be exercised, conducted and controlled by a board of directors to be designated as "CHANCELLORS," and such board of directors shall have power and authority to sell, assign, transfer, mortgage, convey or otherwise dispose of all property and assets of the corporation on such terms and conditions as they shall prescribe.

It was never intended that the College should compete with nor supplant any of the existing or future scientific roentgen-ray and radium societies. Nor did the founders of the College have any other thought than that this corporation should be a non-partisan group of mature radiologists selected by invitation from members of the existing regular scientific radiological bodies, and in that new fellowship assist in every possible manner the efforts of all radiological societies to establish the science of radiology upon the highest possible professional plane.

When one glances through the College roster, he sees names of radiologists from every representative section of America, and these men stand high in professional achievements in their individual communi-

* President's Address before the Tenth Annual Convocation, American College of Radiology, during the American Congress of Radiology, Chicago, Ill., Sept. 25–30, 1933.

ties—truly an all-American representation. In fact, if these names should all be stricken from the roll or their owners be retired from practice at once, the loss to radiology and American medicine would be well nigh irreparable. Again, look over the list of foreign Honorary Fellows, every one of whom is an outstanding scientist in his own country and each one a loyal and appreciative Fellow of the American College of Radiology. Most assuredly our College has a firm foundation.

It has been the custom of each retiring president to make suggestions for immediate or future action which our College could rightfully initiate and carry out. Many of these suggestions have been very valuable, but it is to be regretted that no sustained effort in any definite direction has as yet been made. By all that is just, and by vested right through corporate laws, our College has the authority and also the ability to guide and direct radiological education in medical colleges, and to prescribe standards of equipment, and demand an acceptable operative basis for hospitals and clinics. Our college is in a position to require adequate safety factors and direct the grading of personnel in all institutions where radiant energy is employed for the diagnosis and treatment of disease.

In order to initiate a concerted move in that direction, I would propose that a committee from the Board of Chancellors be created to inquire into existing practices in hospitals and clinics and then formulate plans which the College may approve and put into early execution. Also that the same or another committee investigate the teaching facilities in medical colleges and submit to the College of Radiology a comprehensive plan for a unified teaching schedule which may be recommended to every medical institution of learning.

At the present time a very sinister menace confronts us. I refer to the commercialized exploitation of our specialized profession by lay organizations. These unquestionable schemes are designed to fatten the pocketbook of their organizers at the expense of the physicians' professional and financial status and the well-being of a gullible public. We are sated with solicitors from so-called hospital benefit associations, medical insurance societies, local mutual medical aid organizations, and every other imaginable kind of a scheme maintained to milk both the profession and public.

Let the standards of the American College of Radiology be such that no self-respecting radiologist will permit his name to be connected with any such exploitation program, and before long efforts of this kind will cease.

The cancer problem is one which should be seriously considered by the fellowship. Its solution should no longer remain solely in the hands of the surgeon nor its intricacies depend on internal medicine for solution. In the thirty-odd years of clinical radiology the curability of cancer per se has been advanced approximately 30 per cent. We claim no individual credit for this achievement but its significance heartens us on to still greater accomplishment. As a suggestion, it would be in order to create an American Cancer Foundation with the American College of Radiology as its nucleate head.

Many other problems will present themselves for solution and action, and it is respectfully suggested that the Board of Chancellors meet two or three times a year, if possible, in order that the Fellowship may carry to fruition some of the excellent suggestions of former retiring officers according to the charter provisions with which our College is legally invested.

A ROENTGEN STUDY OF THE ABSORPTION BY THE LYMPHATICS OF THE THORAX AND DIAPHRAGM OF THORIUM DIOXIDE INJECTED INTRAPLEURALLY INTO ANIMALS*

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OUR PRESENT knowledge of the primary development of the mode of growth of the lymphatic system dates back to 1902, when Florence Sabin first clearly showed its mode of origin and growth. She concluded from her observations that it is derived from venous endothelium by a process of sprouting.

Numerous experimental studies have since been made on the extent and routes of drainage of the lymphatic system of different parts of the body of laboratory animals. Various kinds of particulate matter have been used, such as carmine, carbon, and particularly finely separated particles of graphite, commonly known as "hydrokollag 300." In the instances wherein such experiments have been performed it was necessary at times to expose the glands surgically for injection or to remove them in order to determine the presence or absence of the matter injected. Outstanding among a large number of investigators studying the route of absorption of particulate matter by the lymphatic system is the work of Herring and MacNaughton.[2] By injecting insoluble substances, such as carbon or carmine, into the subcutaneous tissues of the legs of animals and recovering the substances in the lymph nodes, these two workers have been able to prove that the lymphatic system absorbs the substances. They also found that the tissue spaces are not directly continuous with the lymph capillaries and that the injection of an insoluble substance, such as India ink or carmine, into the loose connective tissues may spread it widely through the tissue spaces. Herring and MacNaughton conclude that many of these solid particles are taken up in the cytoplasm cells, which pass through the walls of the lymphatics by diapedesis into the lymphatic system. Their contention is:

> The phagocytic cells are arrested in the first lymph gland on the lymph stream, and the cells carrying solid particles pass from the lymph sinuses of the gland into the lymph tissue of the cortex and medulla of the gland, and eventually discharge their burden among the lymphocytes in these situations. Solid particles and even red corpuscles, arriving at the gland in a free state in the lymph stream, are dealt with by the endothelial cells of the reticulum of the lymph tissues. These cells, analogous to the Kupffer's cells of the liver sinusoids, ingest material, detach themselves, and carry into the lymphoid tissue of the gland in exactly the same way.

This is the explanation of the mode of absorption by the lymphatic system when carmine, carbon, hydrokollag 300, or thorium dioxide is used in studying the lymphatic system.

As is well known, the lymphatic system plays an important part in the domain of physiology, and particularly in that of pathology. Among the many functions attributable to the lymphatics are those of nutrition, of defence of the organism against toxic elements, infectious diseases, and neoplastic elements. Their importance is so well recognized that every effort is being made toward a better understanding of this system.

It was our good fortune to be the first, we believe, to visualize by means of the roentgen ray portions of the lymphatic system in laboratory animals and afterwards in humans by the injection of thorium dioxide subcutaneously, intraperitoneally,

* Read at the American Congress of Radiology, Chicago, Ill., Sept. 25–30, 1933.

Fig. 1. Chest of dog in anteroposterior view. A. Thorium dioxide in lymphatics of diaphragms. B. Substernal glands. C. Interlobar fissure.

intracardiacly, intradermally, intrapericardially, and intrapleurally, without surgical intervention.

In a preliminary report[4] we stated that we were able to visualize lymph nodes and vessels of different parts of laboratory animals, principally the popliteal, inguinal, mesenteric, and axillary nodes. Since the publication of our preliminary report on the visualization of portions of the lymphatic system, we have been able to visualize[5] and trace the route of absorption of thorium dioxide from the peritoneal cavity of humans and animals, through the diaphragm and into the lymphatics of the thorax. These studies were made on rats, dogs, rabbits, and human patients.

While it should be appreciated that our studies of the visualized lymphatics were carried out in great part on laboratory animals, there is no valid reason to believe that the lymphatics of animals have a selective action for the absorption of thorium over those of humans. In fact, we have shown in our work on humans that there is no difference; both absorb thorium alike if sufficient quantity is used. We much prefer animal experimentation because animals are easily procurable and are not difficult to handle and, if necessary, necroscopy is always available.

In the human cases[6] we were able to visualize some of the abdominal lymph nodes and vessels, and also to trace the route of absorption through the diaphragm into the lymph nodes of the chest. The

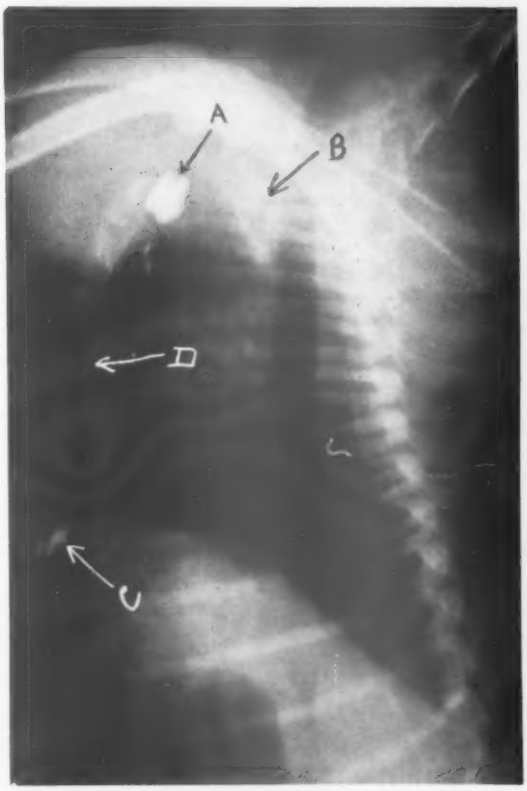

Fig. 2. Lateral view of thorax of same dog as shown in Figure 1. A. Substernal lymph glands. B. Lymph glands in posterior portion of thorax. C. Thorium dioxide in lymphatic system of diaphragm. D. Lymphatic vessels leading down to the diaphragm.

FIG. 3. Anteroposterior view of living human case injected intraperitoneally with thorium dioxide. A. Abdominal lymph glands. B. Abdominal lymph vessels. C. Thoracic lymph glands.

amount of thorium dioxide injected was less in proportion than that used in the animal experiments. For this reason the lymphatic system in the human was not as fully demonstrated as in the instance of our animal experiments. In the latter we were able to clearly visualize lymphatic vessels of the abdomen and diaphragm. We traced the route of absorption from the diaphragm into the lymphatic vessels and nodes of the thorax, visualizing the right and left substernal lymph glands, which are situated on the course of the internal thoracic vessels, and also the anterior mediastinal glands. In the posterior mediastinum we visualized a clump of glands, probably the tracheobronchial lymph nodes. Surrounding and also near the trachea were visualized lymph structures, probably the visceral lymph nodes usually present in animals between the trachea and the esophagus, and also the glands usually present between the trachea and the thoracic duct, and those on the right side of the trachea. The anterior and posterior mediastinal lymph vessels were clearly visualized.

We also reported certain observations in animals injected intrapericardially with thorium dioxide.[1] It was found that, shortly after injection, the thorium had been absorbed by the mediastinal, tracheobronchial and diaphragmatic lymphatic glands and vessels.

The pleural cavity was our next study. Knowing that the pleura and diaphragm are fairly rich in lymphatics, and also that the pleura is susceptible to disease, and that in certain instances there could be a spread of infection to adjacent structures by the lymphatics, we believed that if it were possible to trace the route of absorption from the pleura by direct visualization, under normal physiological conditions, to the lymphatics of the thorax and diaphragm, this would prove interesting and might lead to further observations of importance. For these reasons we undertook certain experimental work along this line which was published as a preliminary report.[6] Since then we have made further observations on additional animals, which we are at present reporting.

Higgins and Lemon[3] have published some very interesting observations in regard to the absorption of particulate matter from the pleural cavity of dogs. Their studies consisted of injecting "hydrokollag 300" intrapleurally into dogs that they might study the route of absorption through the lymphatics by surgical intervention. They were able to outline the lymphatic system of the thorax and trace the route of absorption into and through the diaphragm to the retroperitoneal space. Their observations made it possible for them to clearly and accurately study the lymph nodes and vessels of the thorax of the dog.

According to them, the lymph nodes of the thorax of the dog may be divided into parietal lymph nodes associated with the drainage of the thoracic wall, and visceral nodes associated with drainage of the thoracic viscera.

Parietal Lymph Nodes. These nodes fall into three groups: the sternal, the vertebral and the diaphragmatic.

Visceral Nodes. The visceral nodes may be divided into four groups: the mediastinal, pulmonary, tracheobronchial, and tracheal. The *mediastinal nodes* comprise three or four small nodules which lie either ventral to the superior vena cava or between the veins and the trachea. The *tracheobronchial nodes* are in the superior and inferior angles formed by the division of the trachea and are fairly large. The *tracheal nodes* are variable in number and in position. There are three or four, however, on the right side that are fairly large and quite constant in position. To the right of the vena cava, the right side of the trachea is visible, and on it there are frequently a group of small lymph nodes. On the left side the arrangement of the nodes is similar and they are invariably smaller. In most of the animals studied, lymph nodes were not seen on the pleural surface of the diaphragm. In others, a group of very small nodes was identified at the insertion of the phrenic nerve into the diaphragm.

Lymph Vessels. These may be conveniently divided into two systems draining the right and left sides. On both sides, the subdivision may be carried into the dorsal and ventral. The dorsal division may again be divided into an upper and a lower subdivision. These vessels connect with the various lymph nodes of the thorax. The drainage of the lower dorsal costal pleura on both sides is formed by a number of small vessels, usually arranged in groups of three or four, which pass dorsal to the pars lumbalis of the diaphragm to a lymph node in the retroperitoneal space just above the upper pole of the kidney. This node, in turn, is connected by lymphatic vessels to the cisterna chyli.

Higgins and Lemon further observed that in the course of the lymphatic vessels through both the anterior and posterior mediastinum, communicating lymph channels permit the interchange of lymph from the two sides of the thorax.

The explanation of the distribution of lymph nodes and vessels of the thorax of the dog by these authors has been of considerable help to us in tracing the route of absorption of thorium from the pleural cavity of animals when examined with the roentgen ray.

In our experiments, when studying the route of absorption of thorium by the lymphatics of the thorax and diaphragm of laboratory animals injected with thorium dioxide intrapleurally and observed by means of the roentgen ray, none but healthy animals were used. Rabbits and dogs were preferred, although we used rats in some of our work. The thorax of the rat is to a certain

Fig. 4. Intrapericardial injection of thorium dioxide in a rat. A. Thorium dioxide within the pericardial sac. B. Shadow of heart within the pericardium.

extent like that of a human. The stomach and intestinal tract also bear a close similarity to those of humans, and for these reasons rats are excellent animals for certain kinds of experiments. However, on account of the small size of the thorax, the rat is not an ideal animal for pleural study. In the instances in which we did use rats we were able to visualize intercostal lymph nodes and vessels such as are found in humans.

METHOD

Roentgenograms were made of all animals before injection. We injected thorium dioxide through a small hypodermic needle, preferably on the right and usually in the ninth interspace, into the pleural cavity, avoiding the lung parenchyma whenever possible. In an attempt to avoid injecting the substance into the lung, all injections were made under roentgenoscopic control. In this manner we could observe the entrance and flow of the opaque medium into the pleura. The amount of thorium dioxide usually used was from 0.5 to 2 c.c., depending upon the size and kind of animal used. Immediately after each injection we made roentgenograms of the animal, and similar examinations were made at intervals of twenty-four hours for from forty-eight to ninety-six hours. Some of the animals were roentgenographed weeks and months later.

FIG. 5. Lateral view of a rat injected intrapericardially. A. Lymphatic structures of thorax visualized by means of thorium dioxide.

OBSERVATIONS

We witnessed one of the most interesting observations we have ever seen when using the roentgenoscope. It was possible for us to see the thorium dioxide leaving the needle and entering the pleural cavity, scattering rapidly through it, and filling in the interlobar fissures. Shortly after the injection of thorium dioxide we could clearly outline lymph nodes situated in the anterior mediastinum, and also lymph vessels and nodes on the opposite side, by roentgenographic examination.

In describing the visualized lymph vessels and nodes observed in our animal experiments we shall limit ourselves to one animal of each group, representing all animals in that group.

Rats. Shortly after injecting thorium dioxide into the right pleural cavity we were able to visualize two lymph nodes in the anterior mediastinum and also the right intercostal lymph vessels leading to the right diaphragm and apparently leading to a lymph node beneath the diaphragm. The left thorax showed the intercostal lymph vessels leading into the left diaphragm.

Dogs. By roentgenoscopic examination the thorium dioxide was seen to spread into the pleural cavity, filling the interlobar fissures. Roentgenographic examination made one hour after injection clearly visualized two large sternal glands, these being the first lymph glands to be visualized. A similar examination, made several hours after injection, showed the following lymph nodes: (1) Parietal Lymph Node Group—

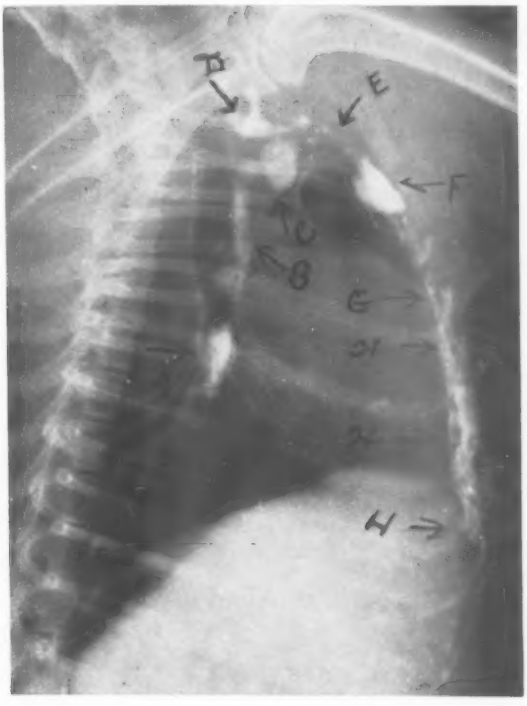

Fig. 6. Lateral view of thorax of dog which was injected intraperitoneally with thorium dioxide. A. Tracheobronchial glands. B. Tracheal glands. C. Anterior mediastinal gland. D. Lymph glands. E. Lymph vessels. F. Substernal gland. G. Lymph vessels. H. Lymph vessels leading down to the diaphragm.

(*a*) sternal and diaphragmatic (we are not certain that we were able to visualize the vertebral group); (2) Visceral Lymph Nodes—(*b*) mediastinal, tracheobronchial, and tracheal (we were unable to visualize the pulmonary group).

Lymph vessels were visualized on both sides of the thorax. The ones on the right were first visualized and shortly afterward the ones on the left, clearly demonstrating that there are connecting lymph vessels between the two sides, as mentioned by Higgins and Lemon. Both the right and left thoracic lymphatic vessels were traced down to the diaphragm, and, in the instance of the vessels on the right side, we believe we traced them through and beneath the diaphragm to lymph nodes, probably in the retroperitoneal space.

Rabbits. The intrapleural injection showed clearly the interlobar fissures. The thoracic lymph nodes and vessels were also visualized. The lymphatic vessels on the right and left were traced down to the diaphragm. The lymphatic vessels on the right were traced through the diaphragm and, as in the instance of the dog, apparently led to lymph nodes in the retroperitoneal space.

The diaphragm in all animals used absorbed thorium from the pleural cavity, but in smaller quantity than when it was injected intraperitoneally. It would seem that the lymphatics of the diaphragm absorbed more thorium or particulate matter from the peritoneal cavity than from the pleural cavity.

CONCLUSIONS

1. We were able to visualize the lymphatic system of the thorax of laboratory animals when thorium dioxide was injected into the pleural cavity and a roentgen examination made.

2. We observed that the injection of thorium dioxide into the pleural cavity apparently does not affect the health of animals. In all of our work we did not observe one case of pleural effusion such as occurs when irritating substances are injected.

3. Thoracic lymph nodes absorb thorium dioxide from the pleural cavity within one hour after injection.

4. The route of absorption of thorium dioxide from the pleural cavity was observed, and in certain instances was traced to and through the diaphragm to lymph nodes apparently in the retroperitoneal space.

5. The first portion of the thoracic lymphatic system visualized was the sternal glands.

6. We believe that the absorption from the pleural cavity was first from the parietal pleura, because the first lymph nodes visualized were the sternal group. The parietal pleural lymph vessels empty into the sternal and intercostal nodes.

7. That absorption also occurs from the visceral pleura is evidenced by the visualization of the mediastinal and bronchial lymph nodes.

8. It would appear that the diaphragmatic lymphatics have greater capacity for absorption of particulate matter from the peritoneal cavity than from the pleural cavity.

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THE OBLIQUE VIEW FOR DEMONSTRATION OF THE ARTICULAR FACETS IN LUMBOSACRAL BACKACHE AND SCIATIC PAIN

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ACCURATE diagnosis of lesions of the lumbosacral and sacroiliac joints is of the utmost importance to the surgeon. We believe it is safe to say that many failures have resulted from operations which have been performed without adequate evidence that the joint operated on was the one causing the symptoms of which the patient complained.

For convenience these joints may be divided into the lumbosacral joint and a right and a left sacroiliac joint. The important structures in the lumbosacral joint are the fifth lumbar vertebra, the sacrum, the lumbosacral intervertebral disc, and the articular facets between the fifth lumbar vertebra and the sacrum. In addition to these structures, the supporting ligaments must be considered.

We have been interested for many years in the articular facets as a factor in producing pain in the back and particularly pain in the back with sciatic radiation. The relationship of the facets to the foramina of exit of the nerve roots is obvious. These facets or articulations make up from a fourth to a third of the margin of the intervertebral foramina. Each of the articulations is composed of two articulating surfaces covered with hyaline cartilage and the margins are enclosed in a synovial lining. They must be regarded as true joints and as having a definitely perceptible amount of motion. This movement has been described by Brown. As these are true joints, with the components of joints, and as changes are demonstrable in them in the skeleton of almost any older person, we have felt that their importance in production of painful conditions of the back must be regarded more seriously.

The articulations mentioned act as stabilizers to the vertebral bodies. They prevent forward displacement of the vertebrae, at the same time helping to form the neural arch. In the course of man's daily activities, much stress and strain is thrown on these joints, and they are subject to movements at all times. The heavy spinal muscles, the active force constantly exerted on the surfaces of the articulations by weight-bearing and active movements of the trunk, make them easily subjected to minor injuries, which, added together, may be sufficient to cause localized traumatic arthritis.

It seems far more reasonable to explain the pain so often seen on a basis of actual injury to the joint than to explain it on a basis of ligamentous strain or injury. We do not mean to infer that ligamentous pain may not be observed. However, in cases in which the complaint is of sudden, sharp pain, low in the back with or without sciatic radiation, often with accompanying sciatic scoliosis, and in which relief is sometimes accorded by manipulative procedures carried out by the physician, or by the osteopath or chiropractor, we believe that the most likely seat of the trouble is in these articulations or facets. Fusion does away with movement of the facets, and this usually relieves the patient permanently. These facets have articular cartilage, and the pain may in some ways be compared to severe pain experienced in locking of a joint, due to a loose body, or, in the case of the knee joint, to a torn semilunar cartilage.

The injury sets up muscular spasm, which may last several days, forcing the joint surfaces into contact and often perpetuating the pain until, either through manipulation, which may change the position of the joint surfaces enough to relieve the irritation, or through gradual relaxation of the muscular spasm, relief is obtained.

With sufficient swelling or effusion into the joint or its surrounding structures there must be some encroachment on the lumen of the intervertebral foramen, enough in many cases to cause definite irritation of the adjacent nerve roots, with resultant sciatic pain. In many cases there will not be sufficient local change to cause sciatic pain but there may be local change enough to account for the presence of persistent lumbosacral backache.

The importance of the facets in the production of sciatic pain has been set forth by Putti. He has advocated the use of stereoscopic roentgenograms to demonstrate the changes mentioned. For many years we have studied such cases with stereoscopic roentgenograms but have often been disappointed in the findings. The upper lumbar facets show up nicely as a rule, but as in most of our cases we were studying the facets between the fifth lumbar vertebra and the sacrum, we were often uncertain of the changes, in spite of the fact that the roentgenograms may have been excellent. It is a well-known fact that the plane at which the articular surfaces of the fifth lumbar facets are set may vary considerably among normal persons (Fig. 1). We have been surprised, however, at the fairly uniform picture obtained with the technique to be described (Fig. 2). The fact that some surfaces of these facets are set at abnormal angles makes interpretation of roentgenograms of less value than in cases in which the usual position is observed.

Several months ago we were impressed with the potentialities of the oblique view described by Meyer-Burgdorff in his monograph on spondylolisthesis, for it seemed to offer substantial aid in studying changes in the articular facets. In the same year that Meyer-Burgdorff's monograph appeared, Hubeny also described the advantages of the oblique position for roentgenography of the lumbosacral region. Prior to this we had occasionally employed similar oblique views of the lumbar region for various purposes and profiting from the experience thus gained, we gradually modified Meyer-Burgdorff's technique to the following routine:

FIG. 1. Anomalous facet on left (*a*). It shows fairly clearly in the anteroposterior view. In the oblique view it is not clearly shown, whereas the normally placed facet (*b*) shows up clearly in the oblique view.

The patient, lying supine on the table, is slowly turned to an oblique position, toward the side to be examined, until the transverse axis of the pelvis is at an angle of

32° with the horizontal. To effect this precise angulation, a rectangular piece of stiff cardboard, measuring 10 by 12 inches (25.4 by 30.48 cm.), with a concave lower edge to accommodate the lower part of the abdomen, is employed. On the cardboard is a line drawn radially from the center of the concave lower edge and marking an angle of 32° with the vertical. The tips of the concave edge are applied to the iliac spines, the cardboard is held in an approximately perpendicular plane, and the position of the patient is adjusted by means of sandbags and cushions until the line mentioned is perpendicular. Additional sandbags and cushions are then used to support and fix the patient firmly in this position. The tube carriage, equipped with a cone 6 inches (15.24 cm.) in length and an aperture of $3\frac{1}{2}$ inches (8.87 cm.), is swung into position, and the axis of the rays is directed vertically to the midpoint of Poupart's ligament on the elevated side. This point also lies almost vertically over the opposite articular facets of the fifth lumbar vertebra, and they will be depicted approximately in profile. The table is equipped with a flat Potter-Bucky diaphragm, and speed screens are employed. Other technical items include a target-film distance of 30 inches (76.2 cm.), 65 peak kilovolts, and 40 milliamperes of current. Time of exposure is varied in pro-

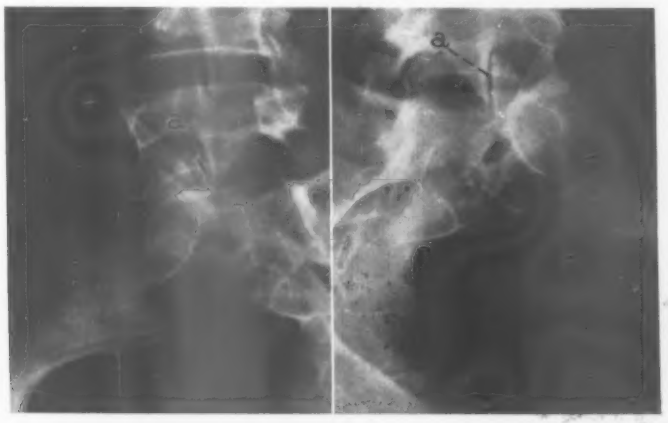

Fig. 2. Right and left oblique views of lumbosacral portion of spinal column, showing facets of normal appearance (*a*).

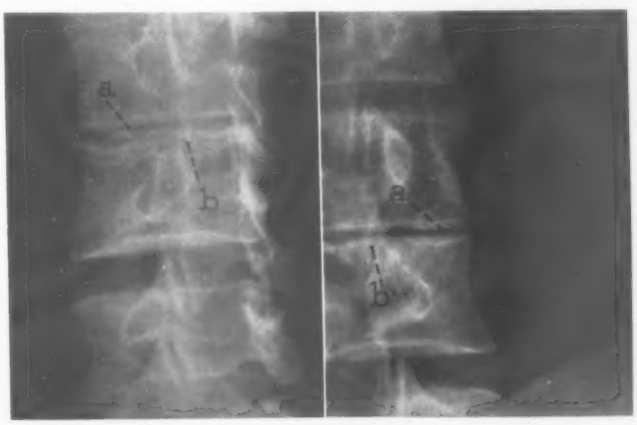

Fig. 3. Narrowing of the third lumbar disc (*a*) due to an inflammatory process. The narrowing of the joint space in the facets (*b*) is clearly demonstrated when compared with the normal facets above and below.

portion to the thickness of the patient's body.

Here it seemed to us we might have an aid of real value in studying the changes in the articular facets. We have been using this technique for several months and believe the results justify continuing its use and recommending it to others who may not be acquainted with it. The importance of its use in spondylolisthesis may be found well set forth in the monograph by Meyer-Burgdorff. We would like to emphasize its use purely to demonstrate changes in the articular facets, which as we have already pointed out, we believe to be of much importance in the production of the syndrome of pain low in the back, with or without sciatic radiation.

The important points to be observed are: (1) Narrowing of the space between the articulating surfaces of the facets (Fig. 3). (2) Marginal proliferation about the articulating surfaces of the facets indicating hypertrophic changes, or in many instances traumatic arthritis (Fig. 4). (3) Fractures through the surfaces of the facets or through the adjacent laminae and pedicles. (4) Increased radiability of the bony structures making up the facets and their supporting structures. (5) Decreased radiability of these structures.

All of these changes may be observed in cases of chronic pain in the back in which no other pathologic change is known to exist other than the localized traumatic arthritis which causes these syndromes. Besides these changes, we may observe in these roentgenograms changes in the vertebral bodies and intervertebral discs. We should also note that the sacroiliac joint is presented in a new aspect, and one which may possibly lead to more accurate determination of lesions there.

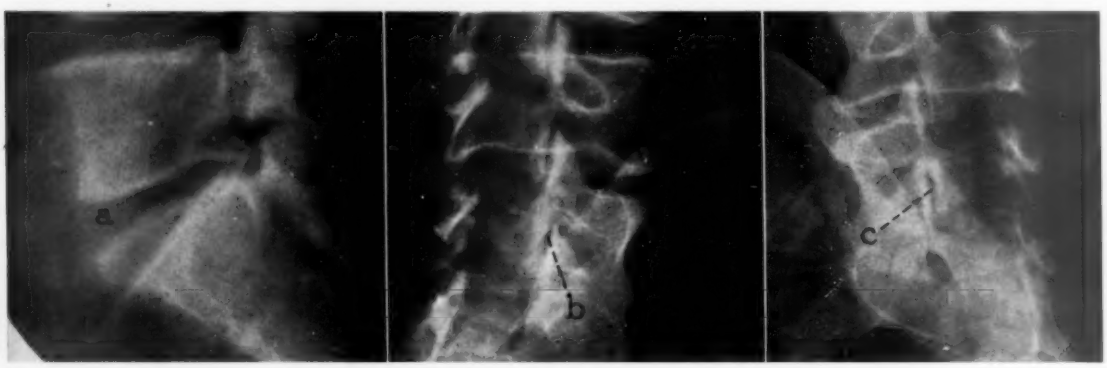

FIG. 4. Narrow fifth lumbar disc (*a*) and changes in the facets (*b*) and (*c*). Slight hypertrophic change (*b*). Marked narrowing of the joint space at the upper margin of the facet (*c*).

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SUBDIAPHRAGMATIC ABSCESS

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IT IS only comparatively recently that subdiaphragmatic abscess has come to the attention of the medical profession. The first autopsy report on this condition was written in 1824 and the first clinical diagnosis of subdiaphragmatic abscess was made by Barlow in 1845. It was not until 1880 that surgical interference was attempted.[5]

For a proper understanding of infections of the diaphragm a knowledge of the anatomy and of the normal and pathological physiology of the diaphragm is essential.

ANATOMY

The diaphragm is a great musculofibrous membrane, composed of muscle and fibrous tissue enclosed within two serous coats, and serves as a partition between the cavities of the thorax and abdomen. The muscular fibers arise from the circumference of the thoracic cavity and converge to a fibrous dome. In front the diaphragm is attached to the inner surface of the cartilage and bony portions of the six or seven inferior ribs interdigitating with the transversalis, and behind to two aponeurotic arches, named the ligamentum arcuatum externum and the ligamentum arcuatum internum, and by the crura to the lumbar vertebrae. The fibers from these sources vary in length, those arising from the ensiform cartilage are very short, and occasionally aponeurotic, those from the arcuate ligaments and from the cartilages of the ribs are longer. Muscles are deficient between the ensiform cartilage and the cartilage of the adjacent ribs. Here the pleura and peritoneum are separated by areolar tissue only, thus forming a point at which pus may readily migrate from one cavity to another. A triangular gap deficient in muscle is sometimes found between the fibers springing from the internal and those arising from the external arcuate ligaments. When this happens the kidney is separated from the pleura only by fatty and areolar tissue. Other weak spots are the points of entrance and exit of blood vessels, nerves, lymphatics and the esophagus. The crura of the diaphragm attaching to the anterior surface of the upper three lumbar vertebrae form an arch for the aorta, vena azygos major, and the thoracic duct. The crura also transmit the greater and lesser splanchnic nerves and the vena azygos minor. The esophagus enters above this at the level of the tenth dorsal vertebra. The highest opening is that of the inferior vena cava, at the level of the eighth or ninth dorsal vertebra.

The diaphragm is supplied by the phrenic nerves, the lower six intercostal nerves, and the phrenic plexus of the sympathetics. It is exceedingly rich in lymphatics and through these the communication between the abdominal and thoracic cavities is free. So close is the connection that infective processes may readily pass through the diaphragm from one cavity to the other, the tendency being for infection to travel up along the lymphatic drainage. This is important to remember in the prevention and treatment of subdiaphragmatic abscess.[4] Figure 1 shows the under surface of the diaphragm with its various openings and weak areas.

Of 173 cases of subdiaphragmatic abscess collected by Lang,[11] thoracic complications were present in 140, or 82 per cent; pleurisy, serous or serofibrinous, in 41 cases; empyema in 16; pericarditis in 16; adhesions, between the lung and diaphragm and ulceration through the diaphragm, in 7; perforation into the lung occurred in 34 cases, into the pleural space in 23, and into the pericardium in 3 cases. In the combined statistics of Maydl,[9] Grüneisen,[6]

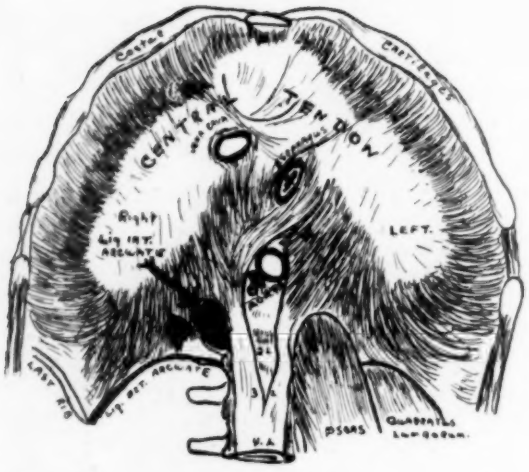

FIG. 1. The under surface of the diaphragm. Areas of deficient muscular development occur in the region between the ensiform and costal cartilages in the region between the internal and external arcuate ligaments, and at the various openings. Here infection can easily enter. (From Gray's Anatomy, 15th edition, p. 353.)

and Perutz,[13] the primary source of subdiaphragmatic abscess in 448 cases was intra-abdominal and in 18 cases intrathoracic.

Anteriorly the diaphragm may extend as high as the fourth interspace on the right side and the fifth rib on the left. Posteriorly the right arch extends to the level of the angle of the scapula (eighth rib), while the left arch lies one inch lower (eighth interspace). The central tendon reaches the level of the eighth dorsal spine.[11] Figure 2 shows the height of the domes of the diaphragm in the anteroposterior and lateral positions.

The subdiaphragmatic space may be defined as that bounded on one side by the under surface of the diaphragm. It is divided by the falciform and round ligaments into a right and left subdiaphragmatic space. Each can be further divided into an anterior and posterior space by the right

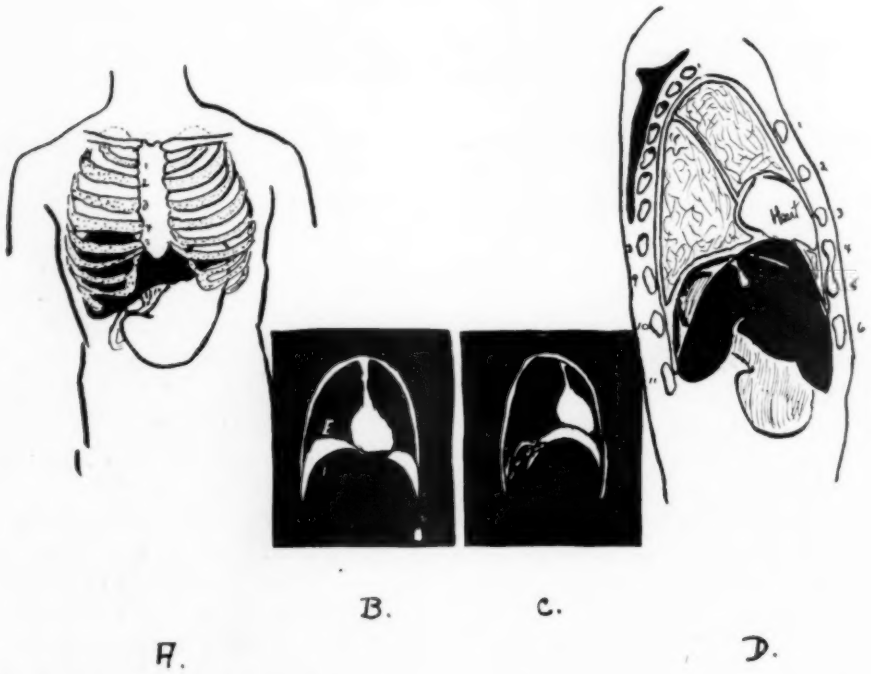

FIG. 2. A. Anteroposterior view of the right and left diaphragm. Note that the right side is higher. D. Lateral view of the right and left diaphragm. Note that the posterior part of the left diaphragm is higher than the anterior. Also the posterior part of the left diaphragm is higher than the posterior part of the right diaphragm. B. and C. The excursions of the diaphragm in normal respiration. B is anteroposterior view and C is the lateral view. One cardinal sign of subdiaphragmatic abscess is the loss of mobility of the right or left diaphragm in respiration; the other is elevation of the diaphragm.

and left lateral ligaments, the right lateral ligament being attached to the liver at the beginning of its posterior slope and the left lateral ligament being attached more anteriorly to the dome of the left lobe of the liver. Figure 3 shows the liver and the attachment of its ligaments to the diaphragm. It is very important to remember the attachment of these ligaments to the diaphragm because the four areas thus formed can be identified by the roentgen ray as normal or abnormal, in this way indicating the route for surgical approach when one of these areas is infected. Figures 4 and 5 show roentgenograms of the normal diaphragm in anteroposterior and lateral positions.

Occasionally pus may find its way retroperitoneally to the right and left lateral

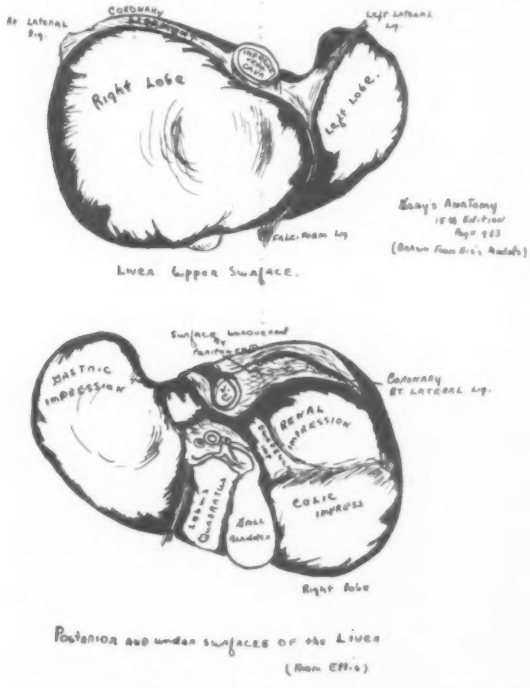

Fig. 3. The ligaments of the liver which attach to the diaphragm and divide it into four subdiaphragmatic spaces. The lower diagram shows the organic impressions of the under surface of the liver. These organs are sources of subdiaphragmatic abscesses, and form the lower wall of the abscess by means of adhesions. The pus must go up anteriorly or posteriorly, being stopped by the right or left lateral ligament. (From Gray's Anatomy, 15th edition, pp. 933 and 936.)

Fig. 4. Roentgenogram of the diaphragm in anteroposterior position. Note that the right diaphragm is higher than the left.

Fig. 5. Roentgenogram of the diaphragm in lateral view. Note the relative positions of the four parts of the diaphragm.

ligaments, thence forward to the falciform ligament, and often as far as the umbilicus, and in this way forms an extraperitoneal subdiaphragmatic abscess.

PHYSIOLOGY

The function of the diaphragm is to keep the lower part of the lungs aerated. Upon contraction of the diaphragmatic muscle the right and left diaphragmatic domes descend, the left dome descending lower on forced inspiration and rising higher on forced expiration, than the right dome. The diaphragm also recedes from the thorax on inspiration, causing the costophrenic angle to be aerated. This action is accentuated by the rotation and elevation of the ribs during inspiration.

ETIOLOGY

According to Nelson[10] in a series of 4,400 admissions, only 4 cases of subdiaphragmatic abscess occurred; 24 cases occurred in the Post-Graduate Hospital in New York City from 1914 to 1928.[14] We have had 6 cases during the past year in St. Joseph's Hospital, Paterson, N. J.

Subdiaphragmatic abscess occurs more often in males than in females, the ratio being about 4 to 1. Also, the anterior subdiaphragmatic space is more frequently involved than the posterior, three times as often on the right side, and ten times as often on the left side. The right side is more often affected than the left, because infection spreads from inflammations of the appendix, from abscesses of the right lobe of the liver, from inflammations of the gallbladder, and the right kidney, and from perforations of the duodenum. The right lobe of the liver is more apt to contain an abscess than the left lobe, because of the more direct distribution of the portal veins to this lobe. Blood-stream infections lodge more easily in the right lobe for this reason. This is also the case in the right kidney. The right renal artery, having a more direct and downward course than the left renal artery, allows blood-stream infection to reach the right kidney more easily.

In an analysis of 1000 cases of subdiaphragmatic abscess made by Lance,[7] 20 per cent were due to appendicitis, 30 per cent to perforated lesions of the stomach and duodenum, 13 per cent to lesions of the liver and gallbladder, and the remaining 37 per cent to miscellaneous conditions of the pancreas, spleen, large intestine, pleurae and other organs.

According to Babcock[1] also, 30 per cent of the subdiaphragmatic abscesses were due to perforations of peptic ulcers. From 4 to 7 per cent of peptic ulcers perforate. Of the number that perforate, subdiaphragmatic abscesses are formed in about 5 to 10 per cent.

Elsberg[11] states that the most common cause of subdiaphragmatic abscess is appendicitis. He collected 75 such cases. In a study of 2,400 cases of appendicitis operated on by Deaver,[2] subdiaphragmatic abscess occurred 20 times. Infection spreads from the appendix, first, as the result of gravity when the patient lies in the prone position, second, direct by the extraperitoneal space, third, by the lymphatics, and fourth, by the portal vein (that is, a liver abscess forms which later breaks beneath the diaphragm). In 106 cases of subdiaphragmatic abscess from appendicitis, reported by Eisendrath,[3] the intraperitoneal variety was present in two-thirds. He reported only 6 subdiaphragmatic abscesses occurring on the left side due to appendicitis.

Ludlow,[8] in a series of 142 cases of amebic abscesses of the liver, reports rupture through the liver in 13 cases causing subdiaphragmatic abscess.

According to Peacock[12] about one-tenth of the perinephritic abscesses, especially those situated anteriorly, break to form a subdiaphragmatic abscess.

About 25 per cent of all subdiaphragmatic abscesses contain gas. This gas is most commonly found when perforations occur in the gut, or when the abscess ruptures through the diaphragm to involve the lungs. The gas seen under the diaphragm is not the air which escapes from

the gut in perforations, for the gas in acute perforations is usually absorbed in a few days, but is rather due to the hydrogen and the carbon dioxide generated in the growth of the colon bacillus which usually accompanies these perforations. This continuous formation of gas causes the roentgen shadow to appear as long as the process continues. Other bacteria found in subdiaphragmatic abscesses are *Streptococcus hemolyticus*, *Staphylococcus aureus* and *albus*, *Bacillus pyocyaneus*, pneumococcus, and numerous other bacteria.

SYMPTOMS AND SIGNS

The possibility of the presence of a subdiaphragmatic abscess should be kept in mind in the following: (1) when a patient has fever, leucocytosis and chills, and yet presents no definite pathology; (2) when a patient looks ill, has symptoms of a chest lesion, but very few chest signs; (3) when a patient has lost weight and presents a general appearance of cancer (of the gastrointestinal tract, for instance) and yet no such condition can be found; (4) when a patient, giving a history of an old perforating peptic ulcer, has a rise in temperature during the day, but does not seem ill. After all perforations and attacks of appendicitis, whether or not an operation is performed, one should watch closely for a rise in temperature accompanied by leucocytosis, which, if explained in no other way, may point to the presence of a subdiaphragmatic abscess. There is a tendency to perforation in all cases of amebic abscess.

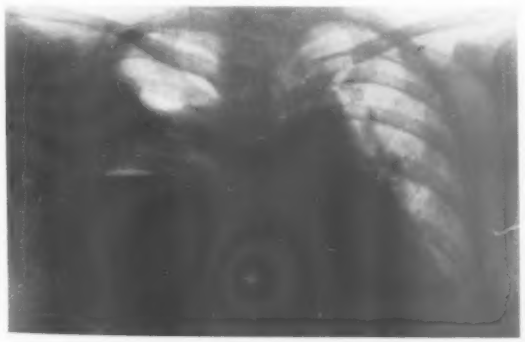

Fig. 6. Case 1. Anteroposterior view. Note height of right diaphragm and gas beneath it. Roentgenoscopic examination showed fixation of the right diaphragm.

Fig. 7. Case 1. Lateral view. Note that the abscess extends beneath both the right anterior and the right posterior subdiaphragmatic spaces.

The following are case reports of our subdiaphragmatic abscesses:

Case 1. M. L., female, aged forty-five, admitted October 1, 1932.

Chief Complaint. Pain in the right side of the chest, with cough of two weeks' duration.

Present Illness. Two weeks ago the patient had a cold in her head. This was followed by grippe. Her family physician ordered her to bed and treated her for grippe. Later he treated her for pleurisy in the right chest. She was sent to the hospital and here the diagnosis of pleurisy or possibly unresolved pneumonia was made. She was coughing up a yellowish material, and was very dyspneic.

Past History. The patient had never been ill, and had had no gastrointestinal or urinary complaints.

Physical Signs. The patient was very dyspneic, cyanotic, and was breathing 28 times a minute. She had loss of breath sounds over the entire right chest. There was increased dullness, but no râles. The abdomen was negative except for some tenderness over the liver area. The temperature was 102°F., the blood count 17,800, with 75 per cent polymorphonuclears. The urine showed a marked trace of albumin, a few epithelial cells, and white blood cells.

Roentgen examination by both roentgenoscopic and roentgenographic methods showed a subdiaphragmatic abscess with a great deal of gas formation. The diaphragm on the right side was raised to the 2d rib anteriorly (see Fig. 6). It was fixed in position and did not move on respiration. In the lateral view (Fig. 7) the gas

FIG. 8. Case II. Anteroposterior view. Shows fluid in the right chest, probably secondary to subdiaphragmatic abscess which is not evident at this time.

has formed in both the anterior and the posterior right subdiaphragmatic spaces.

Operation. Part of the 10th rib posteriorly was resected and the diaphragm was incised. Great quantities of pus flowed from the incision. Colon bacillus was cultured.

The etiology of this case is unknown. From the history and the urine examination it would appear possible that the subdiaphragmatic infection extended from a ruptured paranephritic abscess. The patient died before the diagnosis was verified.

CASE II. F. G., male, aged fifteen, admitted August 25, 1928.

Chief Complaint. Pain in the abdomen, nausea and vomiting, of two days' duration.

Present Illness. Two days ago, after eating tuna fish, the patient had very sudden, severe pains in the right upper quadrant. The bowels were slightly loose, and he started to vomit.

Physical Signs. Tenderness and slight rigidity in the upper right quadrant. The rest of the abdomen was distended. The temperature was 103°F., the white blood count, 19,300, with 86 per cent polymorphonuclears.

Operation. On September 1, 1928, a laparotomy was done. The liver was found enlarged and adherent to the parietal peritoneum. When the adhesions were separated, 10 to 12 ounces of foul-smelling pus and gas were aspirated. The abscess extended to the left, over the stomach, and under the liver. Three rubber dam drains were left in place.

The temperature came down slowly until it reached 100°F. Ten days after the operation it went up again.

Roentgen examination of the chest showed fluid in the right chest (Fig. 8). This was aspirated several times. Roentgen examination on October 4, showed elevation of the diaphragm, fixation of the diaphragm, and a large air pocket underneath the diaphragm (see Fig. 9). Diagnosis of subdiaphragmatic abscess with air was made.

Operation. On October 6, 1928, under 1 per cent procaine anesthesia, an aspirating needle was placed in the 8th intercostal space posteriorly, and pus was found. Two and one-half inches of the 9th rib were resected while the needle was still in place, and the pleura was opened. A pocket was found surrounded with adhesions. The diaphragm was opened alongside of the needle until pus was found. A large cavity of foul-smelling pus was found underneath the right diaphragm. About a pint of pus was aspirated. Three rubber dam drains were left in the wound.

Colon bacillus was cultured.

The patient died on October 12, 1928.

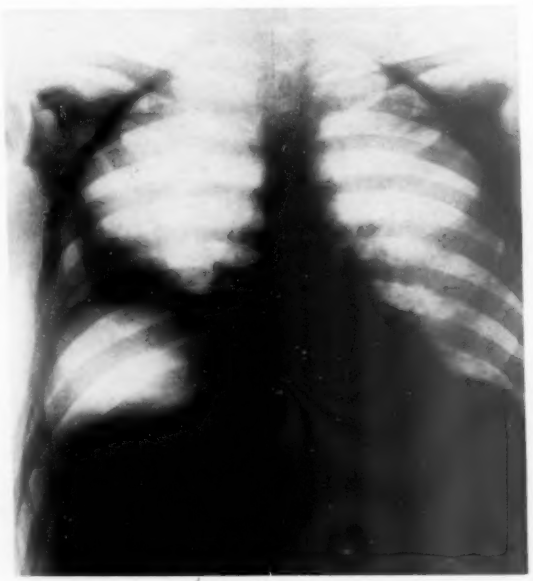

FIG. 9. Case II. Anteroposterior view. Note the high position of the right diaphragm and the gas beneath it. The diagnosis of subdiaphragmatic abscess was made after the fluid was withdrawn from the chest. (See Fig. 8.) There was fixation of the right diaphragm.

The etiology of the subdiaphragmatic abscess in Case II was probably a ruptured peptic ulcer.

Case III. M. J., aged sixty-two, a laborer, admitted January 19, 1932.

Chief Complaint. Dyspnea, cough, chills, fever, of two weeks' duration.

Present Illness. Two years ago the patient had an accident in which his chest was caught between two large boxes. Since then he has complained more or less of pain in his chest. One month ago he had a cold, and two weeks later he began to cough and to expectorate bile. Concomitant with this, his stools became white. The patient had chills and fever and was forced to go to bed. His appetite was poor. He had never had any indigestion previously.

Physical Signs. Physical examination was negative. The temperature on admission was 102°F., the white blood count, 21,900 with 85 per cent polymorphonuclears. The sputum contained bile, and the stools did not.

Roentgen examination showed elevation of the diaphragm and increased density above the diaphragm on the right side (see Fig. 10). The diagnosis was subdiaphragmatic abscess with lung involvement.

Operation. The abscess was drained by an operation on February 2, 1932. In the 10th interspace posterior, 5 inches from the midline, the needle was inserted inward and upward 4 inches. Bile flowed through the needle. The 9th rib was resected. The pleural cavity was not walled off, but was packed with iodoform gauze. Pus showed pneumococci and streptococci. On February 6, 1932, a second operation was performed, the needle being placed through the diaphragm until pus was struck. Then an incision was made through the diaphragm and the cavity was drained with two large tubes. Later lipiodol was injected through the sinus. This clearly outlined the abscess cavity, the hepatic ducts, the gallbladder, cystic and part of the common duct. At laparotomy, performed April 26, 1932, the gallbladder was found small, with no stones. There was an induration at the head of the pancreas the cause of which was not determined. The gallbladder was then anastomosed to the second part of the duodenum.

The patient made an uneventful recovery and was sent home.

The etiology of this case was an obstruction of the common bile duct with infection intervening, causing a liver abscess. The injury sustained several years previously may have been a predisposing factor. The liver abscess ruptured to form a subdiaphragmatic abscess which ruptured into the lung to form a lung abscess.

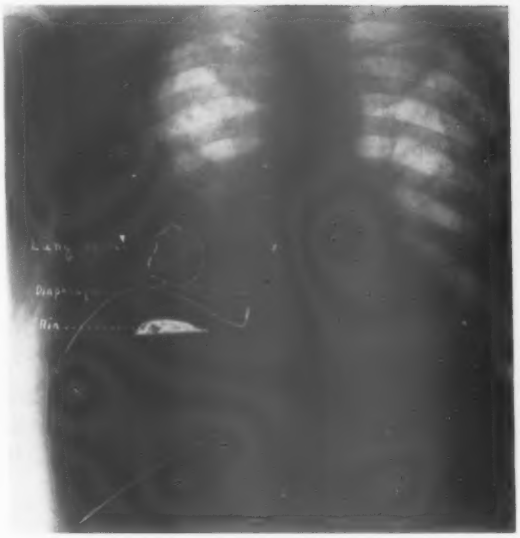

Fig. 10. Case III. Anteroposterior view. Note subdiaphragmatic abscess causing lung abscess. There was fixation of the right diaphragm.

Case IV. J. V. D., aged thirty-eight, laborer, admitted April 22, 1932.

Chief Complaint. Diarrhea, of two weeks' duration.

Present Illness. Three weeks before admission the patient had sudden sharp epigastric pain, intensified with breathing. He could not lie down. The pain disappeared in one week. He had nausea and vomiting with the pain during the first twenty-four hours No hematemesis. One week later he developed diarrhea three or four times a day, which continued until his admission.

Past History. Heartburn and eructation after eating, of twenty years' duration.

Physical Signs. Slight tenderness over the right upper quadrant. Resonance to percussion over the liver area. The temperature on admission was 99°F. The fourth day after admission it was 102.3°F., and the fifth day after admission, 102.2°F. The patient was comfortable and was not in bed. The blood count on admission was 9,600 with 64 per cent polymorphonuclears. The day before operation, April 28, 1932, it was

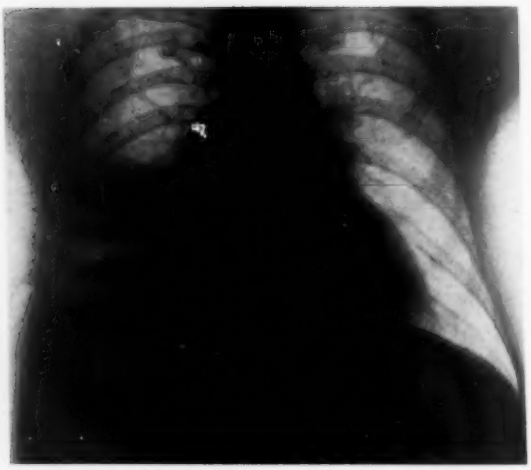

FIG. 11. Case IV. Anteroposterior view. Note gas formation beneath the diaphragm. There was fixation of the right diaphragm.

21,500 with 84 per cent polymorphonuclears. The blood Wassermann was negative.

Roentgen examination showed subdiaphragmatic abscess with air (Fig. 11).

Operation. The patient was operated on April 29, 1932, under local anesthetic. Thoracotomy and open drainage was done. Aspiration was made over the 9th space posterior to the axillary line, and the needle was left in place. One inch of rib was resected. Two rubber drains were left in the wound. No exploration was done. Colon bacillus-smelling pus exuded from the cavity on the opening of the pleura. The patient's temperature after the operation was 101° to 102°F., being 102° on the twelfth postoperative day. The patient was discharged cured.

The cause of this subdiaphragmatic abscess was probably a perforated peptic ulcer, the perforation closing spontaneously.

CASE V. J. S., aged fifty-two, a laborer, admitted July 24, 1932.

Chief Complaint. Severe abdominal pains beginning four and one-half hours before admission.

Present Illness. Four and one-half hours ago he was seized with very sudden, severe abdominal cramps. He had had pain half an hour after meals for the past year.

Physical Signs. The patient had signs of a perforated peptic ulcer. The temperature on admission was 101°F. He was operated on, and a small ulcer 5 mm. in diameter was found on the anterior surface of the duodenum. This was sutured. On the ninth postoperative day the patient had a temperature of 102°F., had chills, and a white blood count of 14,900 with 76 per cent polymorphonuclears.

Roentgen examination of the chest, made on August 8, 1932, showed fluid in the whole right chest (Fig. 12). Culture from the chest was negative. The fluid was aspirated. He continued to have a temperature of 100° to 100.5°F. every day until August 29, when it went up to 103.5° F., and continued at this high level. On September 1, 1932, a roentgenogram of the chest (Fig. 13) showed elevation of the diaphragm to the fourth rib anteriorly. Roentgenoscopic examination showed elevation and fixation of the diaphragm. Laterally, the anterior portion of the diaphragm was more elevated than the posterior (Fig. 14). The left diaphragm was normal.

The right liver was tapped at several points with an aspirating needle in an attempt to find the abscess, but without success.

Operation. On September 11, a laparotomy was performed. The domes of both diaphragms had soft adhesions, easily broken. The right liver did not move with respiration, but the left did. The left liver felt somewhat indurated, and an abscess about the size of a lemon was found near the center of it. This was drained with two rubber tubes and rubber dam drains. The patient's condition was too critical to allow of the further exploration of the right diaphragm.

The patient died on October 11, 1932.

FIG. 12. Case V. Anteroposterior view. Shows fluid in the right chest, probably secondary to subdiaphragmatic abscess.

Autopsy showed a gangrenous right lung, empyema of the right chest, necrotic right diaphragm. The dome of the right diaphragm was adherent to the dome of the right liver, with soft adhesions. The dome of the left diaphragm was adherent to the left liver. There was a pocket of pus between the stomach and under the lobe of the left liver. A large pocket of pus was found beneath the outer, posterior side of the right diaphragm and the right liver, behind the limit of vision at the last laparotomy operation.

In this case the infection undoubtedly came from a perforated peptic ulcer. The infection then spread from the subdiaphragmatic abscess to the thoracic cavity. On August 10, 1932, the thoracic tap was slightly cloudy, and sterile. On August 30, 1932, it contained *Staphylococcus aureus*. The pus obtained from the abdominal operation on September 11, 1932, also showed *Staphylococcus aureus*.

Case vi. O. S., aged fifty, a laborer, admitted July 21, 1932.

Chief Complaint. Bloody expectoration of six months' duration.

Fig. 13. Case v. Anteroposterior view. Note the slight elevation of the diaphragm on the right side. There was fixation of the right diaphragm.

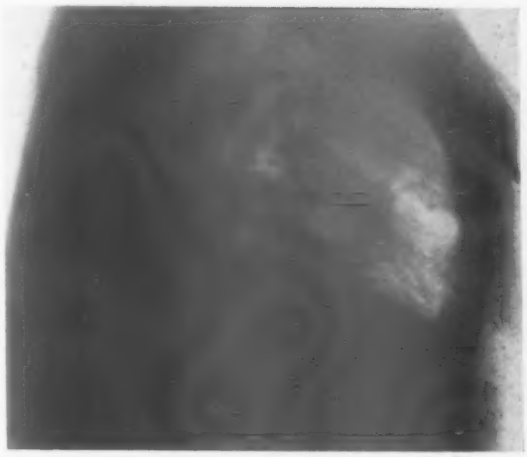

Fig. 14. Case v. Lateral view. The elevation is most noticeable in the anterior part of the right diaphragm. Fluid can also be seen in the posterior part of the chest, which was not visible in the anteroposterior view.

Present Illness. Six months ago the patient began to lose weight, to feel very tired and to cough. He also regurgitated a brownish fluid.

Physical Signs. Physical examination showed an emaciated man, apparently chronically ill. His temperature was 103°F., white blood count, 14,000, 72 per cent polymorphonuclears, and red blood count, 2,700,000.

Roentgen examination of the gastrointestinal tract and gallbladder was negative. The blood Wassermann was negative. Roentgenoscopic examination showed elevation and fixation of the diaphragm (Fig. 15). A diagnosis of subdiaphragmatic abscess was made, and he was operated on five days later.

Operation. On July 26, 1932, a thoracotomy was done in the 11th intercostal space posteriorly, and an exploratory needle was placed through the diaphragm until pus and blood were found. The diaphragm was incised and rubber dam drains placed in position. No bacteria were cultured from the pus. The patient died on the tenth postoperative day.

At *autopsy* the right lung was found to be collapsed, and the pleural cavity to contain 100 c.c. of clear fluid. The abdominal cavity contained some dirty brown purulent fluid. There was an abscess which filled about two-thirds of the liver, the top wall of which was the right diaphragm. The base of the right lung was adherent to the abscess wall.

The etiology of the subdiaphragmatic abscess was a liver abscess, the cause of which is obscure.

CASE VII. J. H., male, aged forty-four, admitted July 25, 1923.

Chief Complaint. Shortness of breath, sweating at night, and coughing, of four or five weeks' duration.

FIG. 15. Case VI. Anteroposterior view. Shows elevation of right diaphragm. There was fixation of the right diaphragm.

Present Illness. Four or five weeks ago the patient had a pain in the right chest, made worse by breathing. He was very short of breath, and developed a productive cough, expectorating yellowish, odorless mucus. He would awaken at night drenched with perspiration. On the day before admission he noticed for the first time that his stools were bloody, and that he had diarrhea.

Past History. He had been a wanderer most of his life, and for the past few years had frequented poolrooms, saloons, etc., at various seaports.

Physical Signs. The chest showed signs of asthma, râles throughout. There was dullness in the right side. The abdomen was distended with no areas of tenderness. The liver was enlarged to three fingers below the costal margin. The temperature was 102°F., the white blood count, 17,500, with 90 per cent polymorphonuclears.

Roentgen examination showed elevation and fixation of the right diaphragm. A diagnosis of subdiaphragmatic lesion was made.

The patient died on October 16, 1923. At autopsy a large amount of bloody serous fluid was found in the right chest. The right lung was collapsed. The right lobe of the liver was practically filled with a large abscess which had ruptured to form a subdiaphragmatic abscess. The colon showed areas of ulceration of the mucosa. *Endamoeba histolytica* was obtained both from the ulcerations and the pus.

This was the only case which we had of subdiaphragmatic abscess arising from a liver abscess due to *Endamoeba histolytica.*

DIFFERENTIAL DIAGNOSIS

The diagnosis of subdiaphragmatic abscess is easy when gas is present. Three-fourths of the cases, however, do not contain air. There are also cases of liver abscesses, liver new growths (see Fig. 21), kidney abscesses, perinephritic and paranephritic abscesses, pleural effusions, and pulmonary consolidations which cause diaphragmatic involvement. The roentgen differentiation then becomes quite difficult. In the case of liver abscess, however, especially if the abscess is large, there is usually a downward displacement of the liver, whereas in a subdiaphragmatic abscess no downward displacement occurs, due to adhesions of the anterior edge of the liver to the transverse colon and the great omentum, and to the anterior abdominal wall. Liver abscess may cause changes in contour, mobility and position of the diaphragm, but the changes are slight. Such are the findings in Case VIII, in which the diagnosis was made by means of a calcareous deposit in the wall of the abscess.

CASE VIII. V. M., female, aged twelve, admitted May 20, 1932.

Chief Complaint. Earache and running ear of one week's duration.

Present Illness. After a brief cold one week ago the patient had an earache, the ear-drum ruptured of its own accord, and a yellowish discharge flowed from the ear.

Past History. Negative, with the exception

that about six years ago, in Italy, a doctor diagnosed an illness which she had as a liver disturbance.

Physical Signs. The patient was feverish, she had a purulent otitis media and slight tenderness over the mastoid region. The rest of the physical examination was negative. The temperature was 105.5°F., white blood count 12,000, with 78 per cent polymorphonuclears and a very faint trace of albumin in the urine.

The next day a left mastoidectomy was done. The temperature gradually came down until the twenty-ninth postoperative day, when it was 100°F. Then suddenly it rose to 105.5°F. again, with a white blood count ranging from 16,200 to 20,000, and polymorphonuclears from 76 to 78 per cent. She had chills.

Roentgen examination on June 18, 1932, showed some elevation of the right diaphragm, with only slight limitation of motion, but showed a ring of calcareous deposit occupying the liver shadow (Figs. 16 and 17).

The abscess was drained by means of rib resection and thoracotomy. After entering the costal diaphragmatic space an exploratory needle was placed through the diaphragm until the abscess was found, then the diaphragm was incised to allow greater freedom of drainage. *Streptococcus hemolyticus* was found. A few days later the whole calcareous deposit came out through the wound and left a much smaller cavity containing air and fluid. Three weeks later the cavity was smaller, but contained somewhat more calcareous deposit in its wall (Fig. 18). The wound was of necessity enlarged several times during this period in order to maintain the opening until healing took place. On November 12, 1932, the temperature was normal and the patient quite well, though the wound was not entirely healed (Fig. 19).

Fig. 17. Case VIII. Lateral view of abscess in right liver.

It is difficult to establish an etiology of this case. It may be that infection from the mastoid spread to the liver through the blood stream. On the other hand, the patient may have had a cyst for some years which became infected during the course of the illness.

Fig. 16. Case VIII. Anteroposterior view of abscess in right liver. Note calcareous wall. June 27, 1932.

Fig. 18. Case VIII. Anteroposterior view of abscess. Abscess is getting smaller. July 11, 1932.

FIG. 19. Case VIII. Anteroposterior view of abscess. Abscess is very small. August 25, 1932.

There are some liver abscesses which give no changes in function in the diaphragm. Here the differential diagnosis is easy, as in Case IX.

CASE IX. E. R., female, aged eleven, admitted April 28, 1932.

Chief Complaint. Chills and fever.

Present Illness. Two weeks before admission the patient had a stomach ache. She vomited during the first week, then she developed chills and a temperature. The family physician treated her for cold and grippe.

Physical Signs. Essentially negative. On admission the child had a temperature of 104°F. The chest and abdomen were negative, with some suspicion of tenderness in the right upper quadrant. The white blood count was 22,400, with 90 per cent polymorphonuclears. The presence of an abscess was suspected.

A roentgenoscopic examination of the right diaphragm was made, but this showed no elevation, no fixation, and normal excursion. A laparotomy was done, and there was found in the right lobe of the liver, to the right of the gallbladder, an abscess cavity which contained 4 ounces of colon bacillus-smelling pus. A necrotic appendix was seen near it. The appendix was removed and drains placed in the abscess cavity. The patient died seven days after admission.

This abscess was probably due to a gangrenous appendix. In spite of the fact that the patient had a liver abscess, she had no signs which showed roentgenologically, probably because the diaphragm was not involved.

Pleural effusion causes fixation of the diaphragm. Fluid obscures the diaphragm. The question now arises as to whether the fluid is due to the thoracic complications of a subdiaphragmatic abscess, or to pleural involvement alone. Fluid due to pleurisy causes depression of the diaphragm. If after removal of the fluid from the chest the diaphragm is found to be elevated, a subdiaphragmatic abscess may be suspected.

Nephritic, *perinephritic*, and *paranephritic abscesses* may, if large enough, cause some elevation of the diaphragm, with some limitation of excursion, but not to the same degree as subdiaphragmatic abscess. In these cases other roentgen findings exist. A flat kidney plate may show the obliteration of the outer edge of the psoas muscle, or the kidney itself may appear large. Stones or pyonephrosis may be seen

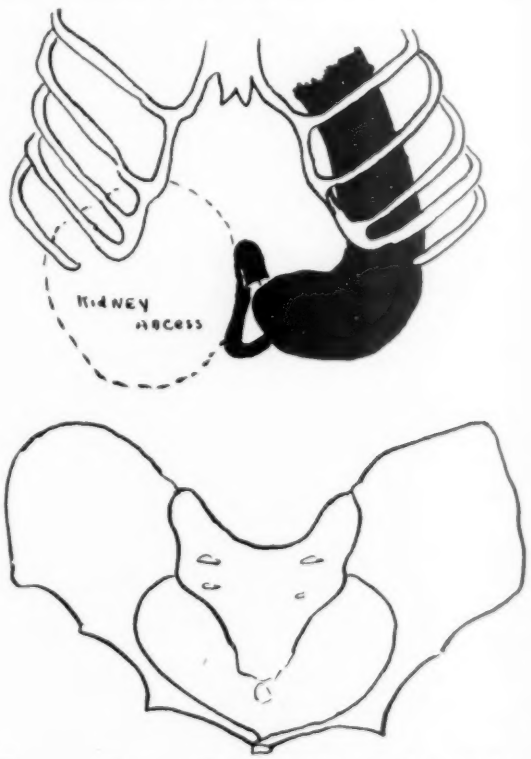

FIG. 20. Case X. Diagram of stomach and duodenum displaced to the left by a large abscess of the kidney.

by pyelograms or urograms. At times an examination of the gastrointestinal tract may show some displacement of the gastrointestinal organs, as in Case x.

Case x. S. C., female, aged seventy-two, admitted September 25, 1921.

Chief Complaint. Abdominal distress, of two weeks' duration.

Present Illness. Two weeks before admission the patient had very severe pains in the epigastrium, and vomited several times. This cleared up in about eight hours. One week later the patient suffered abdominal pain in the upper right quadrant.

Physical Signs. The patient had a mass in the right hypochondrium which was tender to touch. She had a temperature of 102°F., a white blood count of 21,000, with 87 per cent polymorphonuclears. A gastrointestinal roentgen examination was made and showed an extragastrointestinal mass which caused the stomach to be displaced up and to the left (Fig. 20). A laparotomy was done under ether, and a retroperitoneal mass was found just beneath the liver. A diagnosis of an abscess of the right kidney was made. The abdomen was closed, the patient turned on her side, and a kidney incision was made. A large nephritic abscess was found. Two rubber dam drains were left in place. The patient was discharged on November 12, 1921, improved.

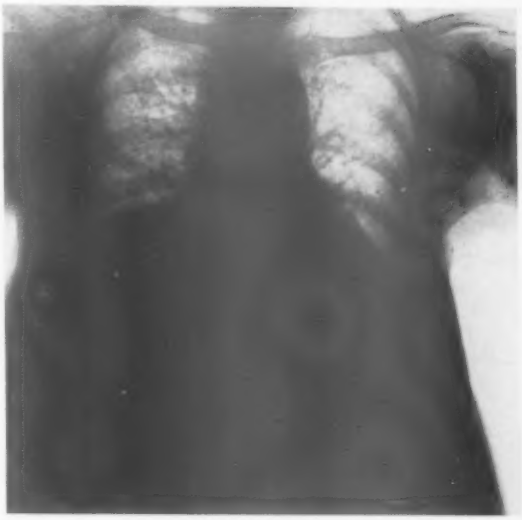

Fig. 21. A. R. Showing a large liver with elevation of the right diaphragm. There was slight motility of the right diaphragm. Patient had a neoplasm of the left eyeball two years previously. At the time of death metastases had occurred to the skin and the liver. Blood count and temperature normal.

TREATMENT

1. *Preventive Treatment.* In operative cases of perforation of peptic ulcers or appendicial abscesses, since lymphatic drainage is upward toward the diaphragm, the patient should be kept in Fowler's position. Sufficient drainage should be provided for in all appendicial abscesses, and care should be taken that the drains are not removed too soon. For the same reason, it is unwise to temporize too long in cases of peptic ulcer which have perforated or are about to perforate, and in cases of appendicitis.

The present treatment of amebic abscess consists in the administration of emetin, coupled with drainage of the abscess by aspiration and not incision.

2. *Curative Treatment.* If a definite diagnosis of subdiaphragmatic abscess has been made and the abscess is known to be pointing toward the anterior subdiaphragmatic spaces, an anterior incision is made, and drainage done. If the abscess is pointing toward the posterior subdiaphragmatic spaces a posterior incision is made, and if it is pointing toward the right anterior and posterior space, a posterior and anterior incision may be necessary. If the posterior incision is done, the tenth rib posteriorly is usually resected, and the needle locates the pus through the diaphragm. The diaphragm is then incised, and the abscess is drained. If a two-stage incision is done, the ninth rib is resected posteriorly, the pleura is sewed to the diaphragm, and a few days later an incision and drainage is done.

RESULTS

There are cases on record in which the patient has recovered without operation after the perforation of the abscess into the lung, and the subsequent drainage of the pus through the bronchus. The usual result is fatal unless an operation is performed.

The mortality rate of the operated cases

is usually proportional to the length of time the abscess has existed, and varies from 20 to 60 per cent. In 107 cases collected by Eisendrath,[3] 84 were operated on, of which 61 lived and 23 died; 23 were not operated on, of which 4 lived and 19 died. Thus 72 per cent of the operated cases lived, and 21 per cent of the non-operated cases lived.

I am greatly indebted to the following surgeons of St. Joseph's Hospital, Paterson, N. J., for permission to cite these cases: Drs. T. A. Dingman, N. Dingman, A. McBride, Wm. Jacobs, and William Neer. I also wish to thank Dr. C. Murn of the medical ward for permission to use his cases.

The roentgenograms were loaned through the courtesy of Dr. H. N. Golding, of the Roentgen Department.

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BARIUM MEAL EXAMINATION OF THE STOMACH IN THE PRESENCE OF UNRECOGNIZED PERFORATED PEPTIC ULCER*

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IN THE course of a clinical study of peptic ulcer and its complications, I encountered and also read of several instances in which roentgen examination of the stomach with a barium meal was undertaken in the presence of a recent perforation. The existence of a rupture was not suspected in the cases referred to, otherwise, obviously, barium would have been withheld. The reason for the failure to recognize the nature of the complication was stated by the individual attending physicians to be the atypical character of the clinical picture. The impression given by those who had the misfortune of administering barium in the presence of a relatively fresh perforation is that the accident is an inescapable one and must be expected to occur in spite of all precautions. My own observations lead me to believe that the casualty is avoidable and that the class of ruptured ulcers referred to as atypical can be readily detected if one possesses an accurate knowledge of the underlying processes involved. On this account, a preliminary discussion of the variety of and basis for symptoms in ruptured ulcer will be entered into, and the subject of barium administration will be treated subsequently.

In the classical perforation as is well known the patient is seized by a violent, agonizing pain which frequently produces collapse. The initial pain, which is generally located in the upper abdomen, rapidly becomes diffuse and maintains its intensity without abatement. Symptoms and signs of a diffuse suppurative peritonitis quickly supervene and unless operation is performed death ensues within a few days. In the atypical cases referred to in the previous paragraph the initial symptoms of perforation are quite similar though perhaps not as violent as those of the classical type. However, subsequent to the onset the clinical pictures in each variety of perforation become increasingly dissimilar until finally they are quite different. The initial pain in the atypical case instead of progressively spreading tends to become more and more restricted. Furthermore, within a relatively short period of time the severe pain of onset diminishes in intensity and after a few hours may entirely subside. The early symptoms and signs of peritonitis which accompany the pain do not increase in intensity and extent but rather decrease with astonishing rapidity. The result is that within a few hours following rupture the manifestations are those of a mild peritonitis generally localized to one abdominal quadrant. In order to emphasize the incomplete and partially effaced clinical picture of perforative peritonitis in these atypical cases at the time patients generally present themselves for diagnosis, the term "forme fruste" was suggested by Singer and Vaughan. The tranquility of the post-perforative course was ascribed to early spontaneous closure of the aperture with limitation of gastroduodenal extravasation.

Unless the examiner is acquainted with the post-perforative manifestations and course of a forme fruste perforation he usually fails to recognize the presence of an acute rupture. Particularly is this the case if the patient is seen for the first time several hours or more after perforation has occurred. Under these circumstances the existence of a penetration or subacute perforation is assumed and roentgen examination with barium undertaken shortly following the rupture. If the fibrinous adhesions which formed and served to seal

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the hole are inadequate they are separated by manipulation and compression incidental to the roentgen study. The result is further extravasation into the peritoneal cavity particularly of the contrast medium. The extent of the barium peritonitis depends upon the presence or absence of relatively firm adhesions in the neighborhood of the rupture.

When the escaped barium is restricted to a fistulous tract or to a pocket it is generally assumed by the examiner that the limitation occurred as a result of adhesions which formed prior to actual perforation. The genesis of the preformed sac is explained in the following manner: The extension or penetration of an ulcer gives rise to an inflammatory response which includes the production of an exudate. As the base of the ulcer is approached collateral inflammatory exudate is poured out on the peritoneal surface before actual solution of continuity occurs. If the penetrative process is a slow one sufficient time elapses between the initial escape of exudate and the onset of true rupture to permit the formation of adhesions in the immediate neighborhood. Under such circumstances the sac which is formed in connection with the ulcer prevents the escape of gastroduodenal content into the peritoneal cavity at the time complete solution of continuity occurs. Since it is assumed that the perforation described above occurs more gradually than the acute type, the term subacute is employed. The subacute perforation is reputed to be relatively silent and on this account is usually not identified clinically as a perforation.

Careful analysis of available facts indicates that the conception of a subacute perforation is an erroneous one. In all but the exceptional case the adhesions which form beyond the ulcer are the result of an acute perforation with escape of gastroduodenal fluid into the peritoneal cavity. The appearance of exudate and the organization thereof follow rather than precede rupture and serve to localize and wall off the infectious material. The accuracy of the above statement has been demonstrated in a number of ways. In many of the cases of so-called subacute perforation, Vaughan and Singer have succeeded in finding free air in the peritoneal cavity, indicating that perforation occurred into the general abdominal cavity and not into a preformed sac. In connection with a study of 25 cases of perigastric abscess most of which were originally attributed to subacute perforations, Singer and Rosi obtained a history of sudden, violent pain characteristic of rupture into the free peritoneal cavity in 24. In a series of cases observed at operation in which the preoperative picture was considered typical of subacute perforation the age of the adhesions, judging from the texture, etc., was found to correspond to the age of the perforation as determined by the history. In other words, the formation of adhesions did not antedate but immediately followed actual rupture.

There is only one case in the literature, so far as can be ascertained, in which it was stated that barium was administered in the presence of an unrecognized perforation into the free abdominal cavity. The case referred to is the one reported by Grégoire who ascribed the failure to detect the perforation prior to roentgenography to the "silent" character of the rupture. The other cases which I consider to be instances of unrecognized free perforation in which a contrast meal was given are reported by their respective authors as instances of subacute perforation with preformed adhesions. On this account, none of the writers consider the lack of recognition of the true perforation avoidable. In the light of what has been said regarding forme fruste perforations it will be of interest to analyze the facts in connection with the reports to which allusion has been made.

A typical example of what may be considered an unrecognized free perforation interpreted as a subacute one in which barium was administered shortly following rupture is recorded by Rosenthal. This author describes the case of a woman, aged

sixty-seven, in whom a gastric ulcer was demonstrated roentgenologically. Three days subsequently the patient was seized by a sudden, severe abdominal pain which rendered her unconscious. At the time the patient was first observed in the hospital there was a paucity of physical signs. The author goes on to say that improvement occurred so rapidly that repetition of the roentgen examination was undertaken. A barium meal showed, following filling of the upper part of the gastric lumen, a shadow about 15 cm. long and 4 to 5 cm. wide which was continuous with the stomach. In subsequent examinations the extragastric shadow was seen to disappear gradually until merely a small niche remained. If one analyzes the available facts the conclusion is reached that because of the patient's rapid spontaneous improvement following the initial pain of onset Rosenthal failed to recognize the presence of a perforation before the roentgen examination. The escape of barium into a circumscribed area beyond the stomach led the author to assume that a subacute perforation had occurred into a preformed sac. The initial pain of onset, however, being of sufficient intensity to produce unconsciousness would indicate that the perforation occurred into the free abdominal cavity.

The other cases in the literature which I interpret as instances of unrecognized perforation with subsequent barium administration are quite similar to the one recorded by Rosenthal. Talamo made barium meal studies in 3 patients in whom it can be assumed from the context of the case histories that acute rupture had occurred a few days prior. In the first the barium escaped from the duodenum into the subphrenic space as far as the midline and failed to spread to other portions of the abdomen. A pneumoperitoneum was also noted. In the second and third cases extraduodenal cavities were observed to fill with barium. Talamo assumed he was dealing with subacute perforations in all three instances. Of particular interest is the case reported by du Mesnil de Rochemont in which as in Talamo's first case an extraduodenal pocket and a pneumoperitoneum were disclosed in the roentgen examination. At operation widespread adhesions were found in the region of the bulb and the site of perforation appeared completely covered. The author explains the benign course of the perforation on the basis of preformed periduodenal adhesions. That these adhesions were a sequel rather than a precursor of the rupture is indicated in the history which is characteristic of perforation into the free peritoneal cavity and includes sudden onset of intense diffuse pain, physical signs on both sides of the abdomen, and even "abdominal facies." The case of Grégoire assumed by him to be silent was probably a forme fruste perforation for, as he himself records in his progress notes, quite severe pain, which came on suddenly one evening and was followed by a "poor" night, preceded the discovery of the rupture.

In commenting on a report submitted by Bittrolff dealing with perforation of ulcer following a contrast meal, Amberger describes 2 cases of acute rupture which he attributes to roentgen examination with barium. In the first case although the history as recorded is quite typical of a forme fruste perforation a rupture was not suspected. Roentgen examination with barium was therefore carried out three days after the initial, intense pain of onset and a lesser curvature ulcer was demonstrated. No unusual complaints followed. Operation disclosed in the region of the ulcer, small deposits of barium scattered among the adhesions. The absence of noteworthy pain at any time following the barium meal would indicate that rupture occurred preceding rather than following the barium meal. An interesting stomach film demonstrating barium in the peritoneal cavity is illustrated by Crohn, who writes in the legend, "Perforating ulcer showing free barium below the diaphragm. Perforation has apparently taken place during or just before radiographical examination; the ba-

rium has escaped through the perforation and is seen under the diaphragm to the right side." No further data are furnished by Crohn. Judging from similar cases, particularly the one described above, the rupture occurred sometime prior to the roentgen examination and conditioned the circumscription of the escaped barium by the formation of adhesions. An additional case of perforated ulcer in which a contrast medium was seen in the peritoneal cavity by roentgen ray was reported by Darbois and Sobel. To the above list of cases of unrecognized perforations in which barium was administered can be added 4 more which I observed within the past few years.

CASE REPORTS

CASE 1. J. C., a white man, aged forty-three, consulted me on December 8, 1930, on account of post-prandial epigastric distress which had troubled him for at least fifteen years. Included in the history obtained at the time of his first visit was the following pertinent information. On November 24, 1925, approximately five years prior, while working indoors he felt faint and on this account walked outside. Suddenly everything turned black before him and he fell to the ground. When he awoke he was being helped into an automobile to be transported home. Hardly had the car travelled 100 yards when following a jar he felt nauseated, retched and immediately was seized by terrific epigastric pain of a stabbing nature which rapidly spread to all parts of his abdomen. He was compelled to double up to the extent that his knees practically touched his chin. He writhed about in agony and yelled and pleaded for aid. The intense pain continued and on this account the patient was unable to mount the stairs or to walk to his bed without aid.

After arriving home the patient continued to cry out for relief whereupon a physician was summoned immediately but did not arrive until an hour later. The physician prescribed medication by mouth in two doses to be given an hour apart. The patient recalled that his abdomen was "hard as a brick." After the two doses of medicine had been taken the pain moderated and the patient was greatly relieved. That afternoon he felt comparatively comfortable, reading and dozing alternately. During the evening he was seen again by his family physician who was well satisfied with the patient's condition. Nevertheless, it was decided that a prominent surgeon be consulted since the patient wished to avoid any possibility of recurrence.

The patient slept well during the night and awakened the following morning (Dec. 1, 1925) feeling no pain but somewhat weak. He travelled to the surgeon's office where he was examined physically and roentgenologically. He felt no ill effects from the contrast meal but remained home since he was instructed by his physician to do so. On December 5, 1925, without having had any further pain since the day of onset, the patient was hospitalized and operated upon the following morning (Dec. 6, 1925). His recovery was uneventful and he left the hospital December 26, 1925, feeling well. He adhered to his diet for three years during which time he was free from distress. Subsequently he ate indiscriminately and suffered a recurrence of his former symptoms.

When one reads the account of the acute illness as related by the patient five years after its occurrence one is struck by the almost incredulous recollection of details. The uncanny remembrance of the minutiae by a patient is characteristic of perforated ulcer and serves to support the diagnosis. There can be little doubt that the description given by this patient is that of a forme fruste rupture. That this diagnosis is correct is attested to by the observations at operation. I was granted permission to inspect the hospital chart and found that at operation the stomach, duodenum and the surrounding structures were bound together by numerous adhesions exhibiting "subacute inflammation." An "active" duodenal ulcer was also noted. On account of the widespread adhesions, gastroenterostomy which had been planned was not performed and the operation concluded as an exploration. After my investigation I apprised the surgeon, who readily recalled the case, of my conclusions. He then acknowledged that he was dealing with a perforation which had closed spontaneously and which therefore he had entirely overlooked. Of particular interest is the roentgen report of Dec. 1, 1925 which reads, "There is a ten-

der pouch-like shadow projecting from the lesser curvature near the pyloroduodenal junction. The duodenum is widely dilated and exhibits marked stasis." Unfortunately the plates had been destroyed. This roentgen description is quite similar to the ones which appear in the literature in connection with perforation considered subacute.

Case II.* J. D., a white male, aged fifty-one, was admitted February 8, 1929, directly to the surgical service of the Cook County Hospital with a note from his private physician requesting that the patient be operated upon for a carcinoma of the stomach. A single Ewald meal failed to reveal the presence of free acid. Roentgen examination showed a rigid prepyloric deformity which was interpreted by the roentgenologist as malignant in nature. One attending surgeon, judging from the emaciated appearance of the patient and the constant defect in the roentgenograms, considered the tumor inoperable. A second surgeon, who agreed to explore, found a chronic penetrating ulcer of the stomach which was covered over by dense omental adhesions. There were numerous adhesions also between the liver and the stomach. A partial gastric resection was done. The lesion in the stomach was from both the gross and microscopic standpoints benign.

After an uneventful convalescence the patient was discharged and referred to the Out-Patient Clinic. Here it was learned that he had been observed in the Hospital in September, 1928, and received medical treatment at that time for ulcer. Reference to the record of his first admission showed that he had entered five days after experiencing a severe pain which persisted up to the time of admission. The details as to the mode of onset and the actual severity of the pain were not stated. The temperature, the pulse and respiratory rates and the leucocyte count were all normal. The roentgen examination made shortly after the first entrance showed a penetrating lesion on the anterior surface of the stomach midway between the greater and lesser curvatures in the pars media and an incisura opposite the lesion.

Close questioning regarding the particulars in connection with the attack which brought the patient to the hospital in September, 1928, yielded an account typical in all respects of a perforated ulcer. It was assumed therefore that the adhesions which were found at operation and which produced the prepyloric deformity in the roentgenograms of February, 1929, were the result of a rupture which occurred several months prior. After arriving at the above conclusions, curiously enough, upon re-examining the old films which had been made at the time of the first admission, air was discerned beneath the dome of the right diaphragm (Fig. 1). The

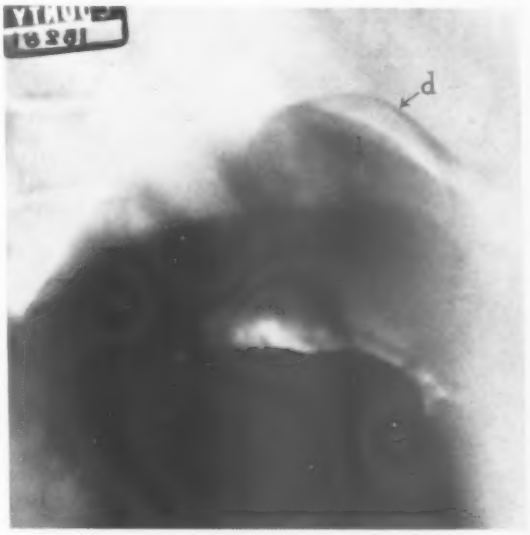

Fig. 1. Case II. Barium meal administered in the presence of an unrecognized perforation. Judging from the history, the rupture occurred six days prior to the roentgen examination. Corroborative evidence of a recent perforation into the free peritoneal cavity is found in the presence of a pneumoperitoneum. In the semilateral view the intraperitoneal air, indicated by a sickle-shaped area of radiolucence is found between the diaphragm (d) and the liver (l).

degree of radiolucence produced by the gas was not sufficient to be conspicuous in the films and indeed required strong light to render it apparent. The presence of the pneumoperitoneum practically established the diagnosis of perforated ulcer. The free air having escaped detection, barium was administered but fortunately without disastrous effects.

Case III. M. F., white male, aged thirty, entered the University Hospital, Chicago, October 5, 1931, on the service of Dr. Adolph Kraft with whom I saw the patient in consultation the following day. In the fall of 1929 the

* This case was described in brief in a previous article dealing with spontaneous recovery following perforation into the free abdominal cavity (see Singer).

patient noted post-prandial pain typical of ulcer which continued to trouble him periodically. About six weeks before admission his pain became more intense and he began to vomit. On his own volition he refrained from all but bland foods with the result that his vomiting vanished and his pain moderated. He then returned to a more or less unrestricted diet. On September 28, 1931, one week prior to his entrance while at stool he developed most excruciating pain on the right side of the abdomen which rapidly became diffuse. The details concerning the course of his acute illness were typical of a forme fruste rupture with subsidence of symptoms after ten hours.

The physician who first treated the patient suspected a perforation, but because of the rapid and striking improvement dismissed his original idea of ruptured ulcer. However, being at a loss to explain the lesion the physician requested a barium meal examination which was made September 30, 1931, two days following the initial symptoms of acute rupture. During the roentgenoscopic examination barium was seen to pass from the stomach into a extragastric pocket over the region of which marked tenderness was elicited. A subacute perforation was diagnosed and the patient referred to Dr. Kraft for surgical treatment. When I saw the patient for the first time, October 5, 1931, a week after the onset of acute pain, he presented no signs of upper abdominal peritonitis. A flat plate of the abdomen failed to show any retained barium. The patient prior to admission to the University Hospital had been ingesting liquids freely without any ill effect. It was safe to assume, therefore, that the perforation was adequately closed and on this account operation for the purpose of suturing the rupture was no longer required. Medical treatment for ulcer which was agreed upon was followed by an uneventful recovery.

CASE IV. J. M., white male, aged forty-five, entered the Cook County Hospital, November 11, 1930, with an admission room diagnosis of penetrating ulcer. His record indicated that he had suffered from typical ulcer symptoms periodically for four years. During this time soda and vomiting had consistently afforded relief. In the past week, however, and particularly the last three days, the pain had been more intense than previously and had resisted the usual aids. For two days prior to admission more or less persistent hiccough was noted.

The patient who appeared rather acutely ill and uncomfortable was considered to have no definite signs of peritonitis. Roentgen examination with barium was ordered and undertaken November 13, 1930, two days following the patient's entrance into the Hospital. During the screen examination, the roentgenologist in the course of manipulation and compression of the stomach noted a stream of barium passing from right to left just above the lesser curvature of the stomach (Fig. 2). For a moment he

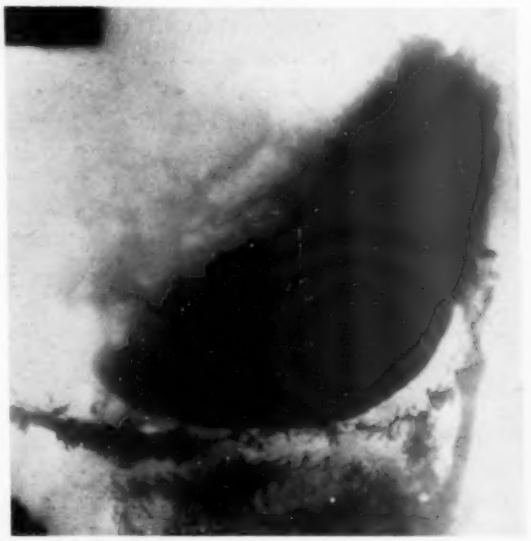

FIG. 2. Case IV. Barium outside of the gastrointestinal tract occupying a position superior and parallel to the lesser curvature of the stomach. The intraperitoneal escape occurred following manipulation and compression of the stomach. Subsequent investigation indicated a previous perforation which occurred four days prior to roentgenography but was overlooked.

was bewildered for he had never before witnessed barium taking such an anomalous course. Realizing soon that the contrast medium was escaping into the peritoneal cavity he hastily took films and then ordered the patient transported to his bed. The pain of which the patient complained upon returning to his ward was taken as a matter of course by the nurses since from the time of entrance he suffered more or less pain at rather frequent intervals. Accordingly the patient received two doses of alkali which had been previously prescribed for pain as needed.

It was not until four hours after roentgenoscopy that I was called to see the patient. At

that time I was able by pertinent questioning to elicit the story that three days prior to admission the patient was suddenly seized by intense, agonizing pain, characteristic of perforation. The initial violent symptoms abated after several hours but he continued to experience sharp knife-like pain upon sudden movement as with change of position. The following day hiccough which at first was extremely painful began. The pain moderated considerably but the hiccough persisted and it

Fig. 3. Case IV. Pneumoperitoneum in a case of reperforation of a peptic ulcer following roentgen examination with a barium meal (see Fig. 2). The air collected beneath the right dome of the diaphragm is separated into two pockets by a septum. The adhesions which comprise the septum are presumably the result of the first perforation which antedated the second by four days. The air seen beneath the left diaphragmatic leaf is within the stomach and overlies the intragastric barium.

was more on account of the persistency of this symptom rather than the pain that the patient entered the Hospital. Upon examination four hours after roentgenoscopy there was diffuse tenderness but surprisingly little, if any, muscular defense. There was slight to moderate distention. No peristaltic sounds were heard. Surgery was advised and en route to the operating room a brief roentgenoscopic examination was made. Because of the unusual picture seen with the roentgenoscope a plate also was taken (Fig. 3). The roentgen examination disclosed in addition to the presence of barium within and outside of the gastrointestinal lumen, free air in the peritoneal cavity. Of special interest in connection with the pneumoperitoneum was the fact that the air which collected beneath the diaphragm with the patient in the sitting position was divided into two pockets. The division was produced by a septum presumably formed by exudate provoked by the original perforation three days prior to admission.

Operation was performed approximately five hours after visualization of the escape of barium from the stomach. A perforation approximately 1 cm. in diameter was found on the anterior surface of the stomach near the pylorus. In the region of the aperture on the serosa were recent ragged adhesions. An area on the under surface of the liver which overlay the site of perforation was the seat of a whitish plaque with similarly torn adhesions. The hole was effectively closed and covered over by a flap of omentum. The peritoneal surfaces were coated white by barium, the particles of which attached themselves intimately to the serous coat. The surgeon attempted to wash away the extravasated barium by irrigation and after flushing the abdominal contents unsuccessfully with several quarts of saline he closed the wound. The patient failed to rally from the operation and died six hours after its completion. It was quite apparent to those who witnessed the operation that the adhesions found about the ulcer were several days old. In all probability the hiccough of which the patient complained prior to entrance was the result of peritonitis from perforation.

COMMENT

Contrary to what one might expect, the danger of a barium meal examination in the presence of a recent unrecognized perforation is in general not a serious one. In the majority of cases in which a contrast medium was administered and in which I was able subsequently to establish the fact that a forme fruste perforation preceded roentgenography no escape of barium occurred. This fortunate outcome was obviously due to the same circumstance which led to the failure to detect the perforation originally, viz., the early and effective spontaneous closure of the hole. Apparently it is only in the small minority of cases that escape of contrast medium into the peri-

toneal cavity occurs. This is due presumably to the lack of firmness of the adhesions which tear or separate as a result of the manipulation and compression incident to the roentgenoscopic examination. Here again, the outcome is generally a propitious one since, following the original perforation and extravasation of gastroduodenal content, the exudate becomes organized particularly about the site of rupture. The resulting adhesions being generally located in the region of the stomach limit the escape of barium to a small pocket or sinus and thereby prevent the occurrence of diffuse symptoms and signs.

It is only in the exceptional instance, exemplified by Case IV of this report, that escape of barium into the free peritoneal cavity occurs. It is not to be implied, however, that the case referred to is thought to be the only example of inadvertent roentgen examination with serious consequences. Although no similar example has been encountered in the literature it is quite probable that other patients have suffered from diffuse barium peritonitis, some with a fatal outcome due to the same cause. However, due to the reluctance on the part of the profession to publish what might reflect on the author's judgment, it is difficult to estimate the true incidence of the disaster. The escape of barium into the general peritoneal cavity occurs presumably when adhesions which close the initial perforation and which lead to sac formation near the site of rupture are inadequate. The inadequacy of the protecting adhesions is due in turn usually to the limited period which elapses between the time of rupture and the time of roentgen examination.

SUMMARY

There are a number of cases recorded in the literature and also encountered personally in which roentgen examination with a barium meal was undertaken in the presence of an unrecognized perforation. The failure to detect the rupture was generally ascribed to the atypical clinical picture which followed perforation. The symptoms and signs in the group of cases referred to were not those of a diffuse, progressive peritonitis but rather those of a localized receding inflammation. These cases were considered instances of "subacute" perforation, a type which does not lend itself to clinical recognition. The impression gained is that the untimely administration of a contrast medium is under these circumstances unavoidable.

Clinical and roentgenologic study indicates that the so-called subacute perforations are actually acute and that the explanation of the mild post-perforative course lies in the early spontaneous closure of the hole. If carefully interrogated, patients with atypical perforations describe a sudden, violent pain of onset identical with that of the classical rupture. However, shortly or immediately following the initial extravasation, due to spontaneous sealing, covering or obturation of the hole, further seepage is prevented and the intense pain of onset rapidly subsides. The symptoms and signs found at an interval after the initial, dramatic manifestations have occurred are those of a low grade, localized peritonitis which promptly abates. On account of the mildness of the post-perforative course, Singer and Vaughan have designated this type of perforation as "forme fruste" and have indicated that it can be detected rather readily.

As far as can be ascertained no article dealing directly with the subject of barium meal administration in the presence of an unrecognized perforation has previously been published. Nevertheless, in the course of general reading on the subject of perforated ulcer nine instances of roentgen examination with a contrast medium in the presence of an undiscovered rupture were encountered. To this number four personal observations are added by the writer. In all of the cases recorded in the literature and in three of the four herein described the inadvertent roentgen examination apparently led to no harm. However, in the fourth patient of this report the administration of a barium meal was followed by and presumably caused a fatal termination.

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MULTIPLE DIVERTICULA OF THE JEJUNUM AND DUODENUM

SIMULATING GASTRIC DIVERTICULA AND COMPLICATED BY CHOLELITHIASIS*

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THE RARITY of jejunal diverticula, as well as the roentgenographic peculiarities and clinical complications of the following case, constitute the reasons for its publication.

Miss C. W., aged fifty, nurse, was admitted to the Colorado General Hospital on August 25, 1932, for nausea, colicky epigastric pain and continuous vomiting following an appendectomy and cholecystectomy at another hospital six weeks previously. Family history negative. Patient has suffered from nausea and vague gastrointestinal distress for several years but has never been jaundiced or bedridden. At the previous operation, numerous gallstones had been found. On admission, patient appeared very weak and anemic, and required sedatives to control pain. Temperature 100.5°F.; pulse 92. Wassermann reaction and urinalysis negative. Blood examination: Erythrocytes 4,100,000; leucocytes 6,850 (polymorphonuclear leucocytes 91 per cent, small lymphocytes 9 per cent); Hb, 79. Van den Bergh reaction showed 3.75 mg. bilirubin per 100 c.c. blood. Icterus index 15. Gastric analysis: free HCl 10, combined acidity 20, blood (occult) +2. Roentgen examination, August 26, 1932 (Fig. 1): "Marked cardiospasm. Several pouches of barium retention over lesser gastric curvature near pylorus, suggestive of diverticula. Several barium filled pockets, probably diverticula, are seen in the duodenum and proximal jejunum. No residue in diverticula after twenty-four hours. Pylorus and duodenal bulb apparently negative. No six-hour gastric residue. Some residue in diverticula. Gallbladder and appendix not visualized. Marked hyperspasticity, stasis and ptosis of colon. Diagnosis: Duodenojejunal diverticulosis. Patient vomited about 200 c.c. of barium mixture twenty minutes after ingestion. Patient's physical condition does not allow erect roentgenography or roentgenoscopy."

In spite of several blood transfusions, the patient's physical condition grew steadily worse so that an exploratory laparotomy as a last resort was decided upon. On the operating table, however, patient soon showed alarming symptoms of shock so that only a few adhesions in the gallbladder region and between the stomach and abdominal wall were severed and no detailed exploration nor further surgery could be attempted. Patient was immediately treated for shock but did not rally and died six hours after operation (September 5, 1932).

The post-mortem examination showed the following changes:

The body is that of a very poorly nourished female, length 156 cm., weight 41.4 kilograms. There is a moderate icteric tint of the skin and conjunctivae. There is a fresh surgical incision extending from the level of the ensiform process to the umbilicus, slightly to the left of the midline. A moderate amount of extravasated blood in the subcutaneous tissue and muscle in the region of the recent surgical wound is noted. There is a small amount of free blood in the peritoneal cavity. The surface of the descending colon is dark purplish-red in color. The small intestines are markedly distended and their peritoneal surfaces are deeply congested. The transverse colon and duodenum are adherent to the under surface of the liver and to the site of the gallbladder.

The liver is 1,275 grams in weight. The capsule is smooth, the surface of a pale brownish-red color. The cut surface of the liver shows dilatation of the larger bile passages. About the ducts the liver tissue is green in color. Intervening tissue is pale pinkish-brown. The common duct is markedly distended admitting the index finger with ease. Near the papilla of Vater there is an oval stone, 1.5×1 cm., which has a finely granular, light brown surface and a laminated internal structure. This stone is impacted in the duct and held fast by a proximal constriction in the duct.

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The stomach is markedly dilated. The mucosa shows a mild degree of post-mortem autolysis. Numerous petechiae are present in the mucosa of the lower part of the greater curvature. Slightly above and anterior to the papilla of Vater there is a large diverticulum which is 4 cm. in diameter. The mouth of the diverticulum is 1 cm. in diameter. Its walls are very thin and fairly smooth. A narrow rim of the sac about the mouth of the diverticulum is adherent to the outer wall of the intestine. About 2 cm. below this diverticulum there is a small diverticulum about 1 cm. in diameter. A third duodenal diverticulum, about 3 cm. in diameter, is present just proximal to the duodenojejunal flexure in the upper and anterior wall of the duodenum. It is similar in structure to that of the above mentioned diverticula. In the jejunum there are 59 diverticula located in the proximal 50 inches. For the most part these diverticula are located along the concave border of the gut at the attachment of the mesentery. Most of them extend into the folds of the mesentery, although an occasional small diverticulum arises slightly to the side of the mesenteric attachment. The jejunum is markedly dilated and its walls are deeply congested. The plicae circulares are markedly increased in height and stand out very prominently. The spaces between the folds contain the mouths of the diverticula. Over the peritoneal surfaces of the diverticula are seen small dilated veins which course over the outer surface of the diverticula and enter the mesentery near the apex of the diverticula. The largest diverticula are located in the proximal portion of the jejunum. These are equal in size to that seen in the duodenum. Towards the distal portion of the jejunum, they decrease in size. The smallest diverticula are about 1 cm. in diameter. The mouths of these are equal to the diameter of the sac. Diverticula are not found in the ileum and large intestine (Fig. 2).

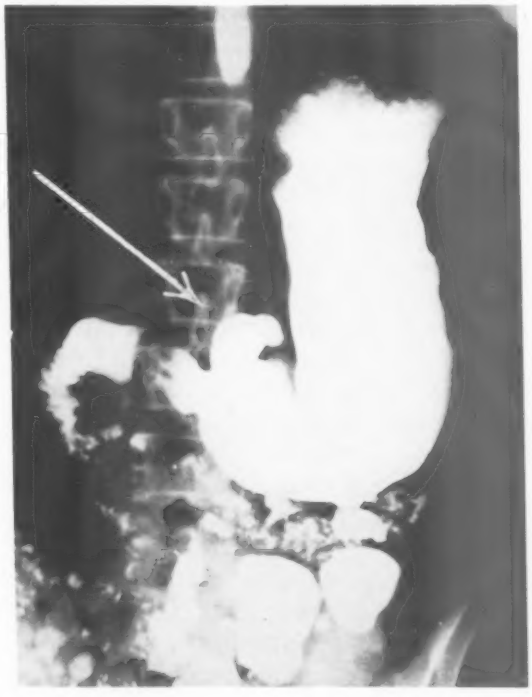

Fig. 1. Roentgenogram of stomach and proximal portion of small intestines thirty minutes after barium ingestion. Cardiospasm. Large diverticula noted. Arrow points to jejunal diverticula simulating gastric diverticula.

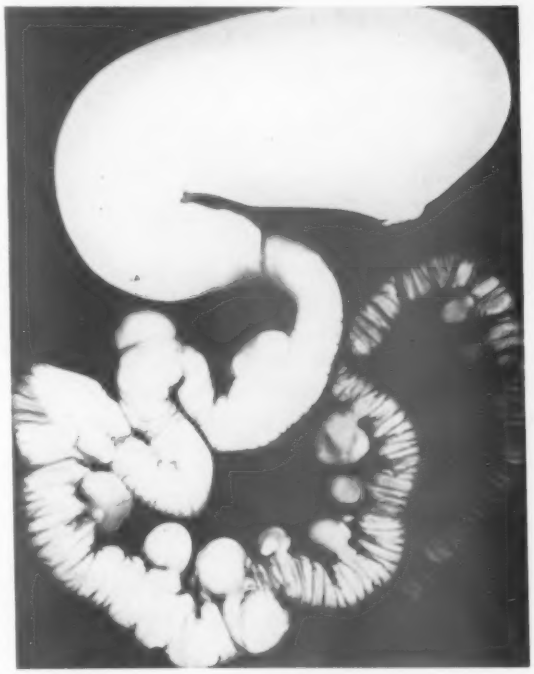

Fig. 2. Radiopaque filling of stomach and proximal portion of small intestines after evisceration of cadaver.

Microscopic Examination of the Diverticula. Sections through the smallest diverticula show the presence of all the layers of the intestines although the muscularis externa is markedly reduced in thickness. In places only a thin layer of the longitudinal muscular layer is present. In the medium-sized diverticula, the muscularis externa is present in the wall of the diver-

ticulum for a short distance near the attachment of the intestinal wall. Only small scattered bundles of longitudinal muscle fibers are seen in the apex of the diverticula. The large diverticula show no trace of muscularis externa except for a slight prolongation of muscle bundles into the wall of the diverticulum near its attachment to the wall of the intestines. The muscularis mucosae is present in all of the diverticula examined. The submucosa appears markedly reduced in thickness in the larger diverticula. The mucosa of the diverticula shows marked autolytic changes. There is an acute exudative inflammatory reaction throughout the walls of the diverticula. The mucosa is similar in appearance to that of the mucosa of the jejunum. In the region of the union of the folds of the mesentery at the apex of the diverticula, an occasional large vein and artery are seen embedded in adipose tissue.

Diagnoses. (1) Postoperative paralytic ileus; (2) obstructive jaundice due to obstruction of the common duct by a gallstone; (3) multiple diverticulosis of the duodenum and jejunum.

DISCUSSION

Diverticulosis of the jejunum is rare, as indicated by the report of Helvestine in 1923 who found 27 cases in the literature, and the more recent compilation of Gisbertz, who found 50 cases of jejunal or ileal diverticula in the literature. On the other hand, duodenal diverticula are comparatively frequent in occurrence. In 1920, Case reported 85 cases of duodenal diverticula in 6,847 gastrointestinal examinations; in this number only 5 cases of jejunal or ileal diverticula were found.

The diverticula in this case are limited to the duodenum and proximal part of the jejunum; 3 in the former, and 59 in the latter. Most of the diverticula are situated in the concavity of the intestines and between the layers of the mesentery. A few are located slightly to the side of the attachment of the mesentery. The diverticula appear to decrease in size towards the distal part of the jejunum.

In the smallest diverticula, all of the layers of the intestinal wall are represented, although there is a marked atrophy of the muscularis externa. In the large diverticula, the muscularis externa is absent at the apex and present only at the base of the diverticula. Because of the absence of the muscularis externa, this type of diverticulum is regarded as a false diverticulum as distinguished from the traction and congenital diverticulum, or true diverticulum, in which all the coats are represented. This differentiation, however, is misleading since both true and false diverticula are present in this case, and transition stages between the two forms are noted. It would be less confusing to designate these diverticula simply as pulsion diverticula without reference to the presence or absence of the muscularis externa.

The interesting roentgenological features of this case, i.e., the simulation of gastric involvement by overlapping diverticular shadows of the small intestines, has been emphasized repeatedly in the literature (Köhler, Briggs and Hurst, and Buckstein). All of the cases reported, however, referred to duodenal diverticula only. Ordinarily a differential diagnosis offers no difficulties. In roentgenoscopy, the progress of gastrointestinal filling can be observed and the relationship of barium pockets to stomach or intestines can easily be determined. Upright positions yield the characteristic fluid levels. In doubtful cases, a separate visualization of the intestines by means of a duodenal tube filling ("duodenogram" after Buckstein) may be obtained. In our case, the extremely weak condition and the persistent vomiting did not permit any of these procedures. In addition, only few diverticula and incidentally only those in close proximity to the stomach were filled at the time of roentgenography, and these diverticula showed little tendency to prolonged barium retention. This may have been due to violent hyperemesis. A visualization of the mucous relief of the stomach was tried but without success.

Diverticula of the jejunum are most frequently found accidentally at post-mortem examination, and are usually symptomless during life. However, cases have been reported in which these diverticula produced

severe clinical manifestations. Terry and Mugler report a case in a woman upon whom operation was performed for intestinal obstruction following the formation of an enterolith in a jejunal diverticulum. Formation of an enterolith and acute inflammatory changes leading to intestinal obstruction are described by Kaspar.

In this case, the diverticula caused no specific symptoms. The illness was ascribed to cholelithiasis and obstruction of the common duct. The inflammatory changes in the walls of the diverticula were apparently terminal and secondary to the paralytic ileus which developed subsequent to an abdominal operation. There is no evidence of the usual etiological factors present in this type of diverticulosis, namely: (1) long-standing chronic passive congestion leading to alternate dilatation and emptying of the veins supplying the intestines; (2) obesity followed by cachexia, and (3) evidence of increased intra-intestinal pressure. Although combination of cholelithiasis and intestinal diverticula has been reported by Vorhaus and Rothschild, it is improbable that the two bear any etiological relationship since gallbladder infections are very frequent at the age favored by diverticulosis.

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PRIMARY CARCINOMA OF THE DUODENUM*

CASE REPORT

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THE RECENT contributions of Meyer and Rosenberg[1] and Mateer and Hartman[2] have served to emphasize the rarity of primary carcinoma of the duodenum, but none the less to stress the importance of its early recognition if surgery is to offer more than palliative relief. The fact that Mateer and Hartman mention the roentgen evidence as one of three early findings should stimulate the roentgenologist to greater efforts, particularly when one considers that it was present in but 50 per cent of the cases reported by them. These cases, moreover, were to be considered rather advanced.

The small percentage of successful roentgen demonstrations of duodenal neoplasms is not surprising when one considers the elusiveness of these lesions to the roentgenologist. Because of the speed with which the second and third portions of the duodenum empty, a small lesion is easily overlooked unless it is producing a moderate degree of obstruction to the flow of the barium meal. Usually the duodenum is not filled in its entire length at any one time. Only small portions of it are seen as the bolus of barium passes rapidly from the bulb to the duodenojejunal flexure. One is therefore usually limited to the alterations seen in the mucosal patterns outlined by the barium remnants in demonstrating abnormalities of the duodenal lumen.

The result of the above mentioned handicaps is that unless the lesion is located in the first portion of the duodenum or is producing some degree of obstruction in the mid or distal portions, a neoplasm of any nature is difficult to recognize. The paradoxical ease with which a benign ulcer crater or a diverticulum is recognized (because of the retained barium) serves to emphasize this.

The following case is reported particularly to show its rather unusual roentgen findings. Although the lesion in this case was causing no appreciable obstruction (no remnants of the motor meal being present at five hours), a definite filling defect was demonstrated.

We are indebted to Dr. Franklin M. Hanger for his kind permission to report the following case:

CASE REPORT

W. P. (300602), a male, aged fifty-nine, was first admitted June 1, 1931, complaining of general weakness and vague upper abdominal pain of three months' duration. There was nothing in the family history of significance. His past health had been generally good except for "typhoid-pneumonia" at twenty-two years of age. For the past three months he had had substernal pain with vague epigastric distress when distraught. He also complained of mild dyspnea on slight exertion but there was no edema or palpitation. There was no unusual bowel disturbance or change in the character of his stool. He had had no belching or vomiting. He had gradually lost 15 pounds in weight in the previous year. The patient himself stressed the nervous element in discussing his symptoms.

Aside from the fact that the patient appeared rather pale and chronically ill, the general physical examination was negative. No abdominal masses were felt and there was no abdominal tenderness. The rectal examination was negative. The examination of the blood showed a hemoglobin of 55 per cent, red blood cells, 3,760,000; white blood cells, 6,360; polymorphonuclears, 60 per cent; eosinophiles, 7 per cent; basophiles, 3 per cent; lymphocytes, 24 per cent; myelocytes, 6 per cent; reticulocytes, 11 per cent. The urine was negative. The gastrointestinal roentgen study was reported negative (Fig. 1) but shows an obvious alteration of mucosal patterns corresponding to the site of the lesion proved later. A malignancy of the gastrointestinal tract was suspected but

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could not be established. No cause for the blood in the stools could be found. He was discharged unimproved after four days of study. During the following few months he improved under iron therapy for his secondary anemia although the alimentary bleeding persisted.

He was re-admitted in July, 1932. The weakness and anemia had returned, and in addition he had developed jaundice two weeks previously. At this time a firm, rounded mass was palpable in the upper right quadrant. His blood showed: red blood cells, 2,800,000; Hb, 52 per cent; white blood cells, 14,000; polymorphonuclears, 82 per cent. The urine showed 4+ bile. The stools were acholic and contained blood. The serum bilirubin was 22.5 mg. per 100 c.c. The blood urea 0.74 gm.

The roentgen examination of the gastrointestinal tract showed a filling defect in the second portion of the duodenum. It was considered due either to a carcinoma of the common bile duct with invasion of the duodenum or a primary malignancy (Fig. 2).

The jaundice increased in intensity. He was operated upon July 30. The gallbladder was found moderately distended and its walls slightly thickened. A large firm mass nearly 10 cm. in diameter was palpable in the region of the head of the pancreas. A cholecystostomy was performed but the patient failed rapidly and died three days after operation.

Fig. 1. (First admission.) Showing the alteration in the mucosal fold patterns in the second portion of the duodenum.

Fig. 2. (Second admission.) Film of the stomach and duodenum showing a filling defect in the second portion of the duodenum. Note the mass in the lumen displacing the barium, as well as the distorted contour on the medial side which was constant on several films indicating rigidity.

The necropsy showed the stomach and first portion of the duodenum to be distended and to contain a large amount of fluid blood and semisolid friable clots. In the second portion of the duodenum a large, rounded, mushroom-like growth was found measuring 6.5 by 7.0 cm. The edges of the growth were sharply elevated, being raised into an overhanging shelf-like fold. The plicae of the surrounding duodenum were somewhat distorted. The main growth consisted of a fairly firm, pale, grayish-yellow tissue. It extended into the muscularis of the gut wall but did not invade the underlying structure to any appreciable extent. The ampulla of Vater lay almost in the center of the growth. Both pancreatic and common bile ducts when probed were found markedly distended. Microscopic sections (Figs. 3 and 4) showed adenocarcinoma composed of high cuboidal and tall columnar epithelium forming irregular acini and apparently arising from duodenal mucosa. There was no extension beyond the limits of the duodenal wall.

A mild biliary cirrhosis was present superimposed upon which was a recent ascending infection of the bile ducts and an associated acute cholecystitis.

There was a terminal confluent lobular pneumonia which together with the massive hemorrhage into the gastrointestinal tract was apparently the immediate cause of death.

FIG. 3. Low power photomicrograph of tumor showing the sudden transition from normal duodenal mucosa to tumor tissue and the shelf-like elevation of the tumor mass. (Courtesy of Department of Pathology, College of Physicians and Surgeons, Columbia University.)

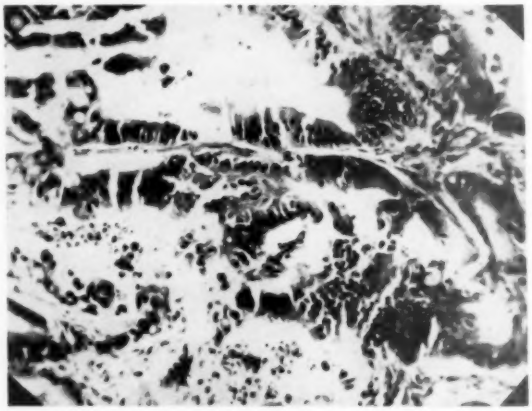

FIG. 4. High power photomicrograph showing the high columnar epithelial cells which formed the greater part of the tumor. (Courtesy of Department of Pathology.)

COMMENT

The growth in this case falls into the group designated as periampullary in the classification given by Mateer and Hartman. This is the most common type according to these authors, 66 per cent of all primary growths of the duodenum falling in this group. The adenocarcinoma seen here is, likewise, the most common type microscopically.

It is interesting to note that although the growth in this case was apparently present for a whole year it had not invaded the surrounding structures and had not metastasized. This fact would seem to indicate that they are more or less locally malignant and thus surgical excision perhaps offers a permanent cure, if the nature of the growth is demonstrated early. It is in this regard that the roentgenologist must attempt to increase his efficiency. Obviously, if a more careful study had been made at the first examination, the alteration of mucosal contours would have been recognized. It will be noted that at the time of the first gastrointestinal series there were signs of intraalimentary bleeding but no jaundice had been present.

The differential diagnosis of the filling defect naturally includes four possibilities: (1) benign tumor, (2) carcinoma of the common duct invading the duodenum, (3) primary duodenal carcinoma, and (4) a carcinoma of the head of the pancreas invading the duodenum. The benign tumor can be recognized because of its smooth contour and the lack of rigidity of the walls at the site of the lesion. The malignancies, on the other hand, give a much more extensive irregular defect, with rigid contours and obliteration of the normal mucosal fold pattern. The type of malignancy as regards the primary site cannot be determined without the aid of the clinical findings. It is obvious that jaundice will be present earlier in the cases of defects due to malignancies other than primary carcinoma. Supra-ampullary defects cannot usually be distinguished from ulcer deformities in the bulb but the lack of ulcer symptoms would be of aid in some cases.

The importance of a painstaking observation of the entire duodenum and of the entire small intestine, for that matter, is obvious, if we are to further narrow the group of cases which we must now designate as the "concealed neoplasm."

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ROENTGENOGRAPHIC MANIFESTATIONS OF URINARY BILHARZIASIS AND CALCULOUS FORMATIONS IN EGYPT, AND INTRAVENOUS PYELOGRAPHY*

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BILHARZIASIS attacks about 70 per cent of the population of Egypt, and produces variable lesions in various parts of the body.

In urinary infections serious complications may follow, e.g., strictures of the ureters, hydro- or pyonephrosis, lithiasis, fistulae, papillomata, and malignant new growths which may invade the peritoneum or neighboring organs causing malignant fistulae.

The affection being so serious, a profound study is essential in every case of urinary trouble in Egypt. The roentgenologist's task in this connection is not an easy one, as he is expected to find out and demonstrate the causal factor and site of the trouble. The advent of intravenous pyelography has facilitated this task, retrograde pyelography being often difficult or impossible in some cases, e.g., in children, or in elderly individuals with enlarged prostates, in cases of bilharzial or other strictures of the urethra, in cases of septic infection of the urinary tract or in cases of bilharzial changes occurring in and around the ureteral orifices, masking the view of the orifices or impeding the passage of the ureteral catheters.

Up to March 15, 1931, I have investigated over 1000 urinary tracts. At the last International Congress of Tropical Medicine and Hygiene held in Cairo, in December, 1928, I submitted a communication referring to 700 cases examined roentgenologically during four years previous to the Congress with analyses of 150 cases. These were referred to in the *Urologic and Cutaneous Review* of September, 1930.[5] In the present paper, 300 more cases recently examined are analyzed. It is advisable to do a cystocopic examination with intravenous pyelography, in cases of renal colic where the ordinary roentgen examination is negative for stones or bilharzial calcifications, to find out the cause of the obstruction or kinking of ureters, nephroptosis or other lesions which may indicate surgical interference. Cystoscopy helps to find out whether the ureteral orifices are involved with bilharzial infiltrations or not. Other cases are pyelographed to see the extent of lesions and damage caused to the urinary tract by bilharzial infection and stones. In some cases the ureters were seen in the roentgenograms to attain the size of the large intestines and the kidneys were hypertrophied and markedly hydro- or pyonephrosed.

Roentgenography of bilharziasis has been dealt with by a few authors. Some roentgenographic manifestations of bilharziasis were mentioned, and the calcified demarcations were described but were dogmatically attributed to bilharziasis by some writers. Seven years ago I began to study the subject unguided by any publication. It seemed to me essential to carry out my study along research lines.

At the last International Congress of Tropical Medicine and Hygiene, it was concluded from my study that bilharziasis manifests itself roentgenographically in the form of cloud-like shadows or calcified demarcations. The calcified eggs deposited in the mucous, submucous and muscular layers of the affected organs were proved to be the causal factor of these shadows.

* Read at the Third International Congress of Radiology, Paris, France, July 26–31, 1931.

In cases of clinical bilharziasis the calcified demarcations were often met with. The presence of bilharzia eggs was demonstrated microscopically in scrapings of post-mortem specimens of organs showing roentgenographic calcified demarcations during life in cases where no clinical bilharziasis existed and where there was positive roentgen evidence of bilharziasis. This was strong evidence that the calcified eggs were the cause of the calcified lines seen in the roentgenograms. In cases collected from the out-patient bilharzial center of the hospital giving an old history of bilharziasis with renal colic, roentgenographic bilharziasis was shown in my previous communication to occur in the following ratio: 38.5 per cent in bladder only; 51.2 per cent in bladder and ureters; 7.75 per cent in ureters only or within the kidney pelvis; 2.6 per cent urethra affected with bladder. I have just come across an unusual case where the roentgenograms demonstrated bilharziasis of the seminal vesicles and ductus deferens together with bladder (see Figs. 22, 23 and 24).

Research showed me that there were some cases of bilharziasis which could be diagnosed during life only by the roentgen ray and I assumed the existence of what may be called *the concealed bilharzial infection of the hollow organs*. In such cases it may be assumed that the eggs do not succeed in penetrating the mucosa (but remain in situ and become calcified, casting shadows on the roentgenograms) resulting in a closed infection with absence of clinical manifestations, e.g., hematuria and ova in the urine. Some of these cases may be cases of old, healed, open infections. Such cases are accidentally discovered in a roentgen investigation of causes of renal colic or some other condition of the urinary tract. This so-called "concealed or closed bilharziasis" is now confirmed by combining results of the clinical and roentgen examination, cystoscopy and post-mortem examination and pathological examination of post-mortem specimens.

At first I thought that roentgenographically dense opaque calcified demarcations indicated heavy bilharzial infiltrations associated with advanced bilharzial pathological changes. This view is no longer maintained in the light of further experience gained by more frequent cystoscopies and post-mortem examinations. In one particular case (Case III) where numerous very heavy calcified demarcations were seen outlining and traversing the bladder, this organ at post mortem showed thin walls and a smooth, grayish mucous surface free from congestion, in contradistinction to what is found in advanced cases of open infection of bilharzial cystitis with dense, thick walls and papillomatous formations with ulcerations and calcareous incrustations. Microscopic examination of scrapings from the submucous layers of the bladder of this case demonstrated the presence of calcified eggs.

The roentgenographic and cystoscopic findings in this case show that *heavy deposition of calcified eggs may be present in the walls of the hollow organs without naked-eye surface changes in the mucosa*. Pathological sections of the bladder made by Dr. Moustafa Fahmy Sorour, Professor of Pathology of Kasr El Ainy Hospital, Cairo, showed that the eggs were for the most part deeply deposited in the submucous and muscular layers. This explains why the surface of the mucous membrane viewed by the cystoscope during life and examined with the naked eye at necropsy was devoid of the usual bilharzial pathological changes (see Fig. 7).

These and other findings indicate that the eggs may be deeply deposited and a closed bilharzial infection can occur and may remain dormant without symptoms, and the affected organs may retain nearly their normal appearance unless infection is lighted up by some means or other.

The capacity of the bladder was found normal in many cases showing roentgenographically heavy calcified demarcations outlining and traversing the bladder zone.

A closed infection may also be accompanied by severe complications, e.g., cica-

trization and narrowing of the ureter with resulting hydro- or pyonephrosis.

I have found that a bilharzial infection may be closed in one part and open in another part of the tract. In the particular case above described (Case III) the bladder was mostly the seat of a closed infection as shown by roentgen rays, cystoscopy and post mortem, while the ureters and kidney pelvis were the seat of an open infection. A definite obstructing papilloma was found at necropsy (see Fig. 5) above the right ureteral orifice corresponding to a calcified patch seen in the roentgenogram (see Figs. 3 and 5); ova were detected in the urine, the right kidney was hypertrophied and hydronephrosed and more than double the size of the left hydronephrosed kidney (see Figs. 5 and 6). Not enough uroselectan was secreted by the damaged kidneys to throw shadows on the roentgenograms. Dr. Sorour has been kind enough to make various pathological specimens for this case and to correlate our clinical and roentgenological findings (see Fig. 7).

It seems reasonable to dissociate the terms "closed" and "concealed bilharziasis." In neither of them do clinical manifestations of bilharziasis reveal themselves at the time of the examination, i.e., no hematuria or ova in the urine and no definite bilharzial cystocopic changes. When there are sufficient calcified eggs, the roentgen examination will give definite evidence of bilharzial infection in the form of calcified demarcations or cloud-like shadows. The term "closed bilharziasis" should be reserved for cases where the pathological examination of surgical sections or post-mortem specimens shows that the eggs are deeply deposited in the submucous and muscular layers and no attempt on their part is made to penetrate the mucosa and to produce changes therein. The closed infection was also described by Dr. Sorour at the International Congress of Tropical Medicine and Hygiene in 1928.

The term "concealed" or "latent bilharziasis" is a more general term which can be applied to closed bilharziasis described above, as well as to old healed cases of open bilharziasis in which the clinical manifestations of the disease have disappeared. Pathological examination in old, open, healed bilharziasis may demonstrate old, healed lesions in the mucosa.

In Tables I and II are given the results of analyses of the 300 cases examined during the last two years up to March 15, 1931, in the Alexandria Government Hospital.

Regional Distribution of Stones. This is given as follows (cases of stones of bladder operated upon without roentgenography in the same period are included): In 143 cases of stones: 17.5 per cent were found in the kidneys, 25.8 per cent in ureters (upper part—0.7 per cent; middle part—3.5 per cent; lower part—21.6 per cent), 58 per cent in bladder, 0.7 per cent in urethra.

Relation between Bilharziasis and Stone Formations. In 51 cases (see Tables I and II) of bilharzial calcifications diagnosed roentgenographically, 19 were associated with calculous formations, giving a ratio of 21 per cent which is nearly the same arrived at by my previous investigations. It can therefore be seen that an undoubted relationship, arrived at roentgenologically, exists between bilharzial changes and stone formations. The extent of this relationship has still to be determined by all other means of investigations.

The above-mentioned statistics in Tables I and II show that bilharziasis contributes more factors to the production of renal colic in Egypt than stones.

DIFFERENTIAL DIAGNOSIS

The calcified bilharzial demarcations attain various forms according to the extent and shape of the bilharzial infiltrations:

I. The pelvic kidney, ureter, or bladder may be outlined partly or completely by dense, opaque, characteristic linear contour (see Cases I, V, VII and VIII).

Diagnosis in such cases is easy. In cases of pregnancy the fetal head in the pelvic cavity sometimes simulates closely a calcified bilharzial contour of bladder. The his-

TABLE I

RENAL COLIC WITH PRESENT OR PAST HISTORY OF HEMATURIA
ova discovered or not
(80 cases)

N.A.D. by X-Rays 40%	Calcified bilharzial demarcations discovered 30 cases, i.e., 37.5%							Stones without calcified demarcations 16 cases, i.e., 20%					Tumor 2.5%
	With stones 10%						Without stones 27.5%	20%					
	Kidney	Ureter			Bladder	Urethra		Kidney	Ureter			Bladder	
		U	M	L					U	M	L		
32	2	—	—	3	2	1	22	9	—	1	6	—	2

TABLE II

RENAL COLIC WITHOUT DEFINITE HISTORY OF HEMATURIA
(220 cases)

N.A.D. by X-Rays 50%	Calcified bilharzial demarcations 51 cases, i.e., 25%							Stones without bilharzial calcifications 40 cases, i.e., 18%					
	With stones 4%						Without stones 19%	10%					
	Kidney	Ureter			Bladder	Urethra		Kidney	Ureter			Bladder	
		U	M	L					U	M	L		
129	—	—	—	8	1	—	42	14	1	4	17	4	

tory and clinical features of the case will make the diagnosis clear.

II. Sometimes the whole bladder area or a segment of the ureteral area shows dense, calcified, irregular shadows limited or unlimited by a calcified bladder or ureteral linear contour. The appearances are usually characteristic (see Figs. 3, 9 and 13). They should be differentiated from:

A. Calcified tumor in the uterus or one of its appendages.

B. Dry fecal masses or concretions in the intestines, more particularly the rectum.

The history of the case, cleansing the bowels by enemas, and taking series of roentgenograms in various positions, cystography, or injection of lipiodol into the uterine cavity will clear up the diagnosis.

III. When the roentgenographic bilharzial manifestations occur in the form of single or multiple patches in the bladder, ureter, or kidney pelvis, differential diagnosis is rendered more difficult. These localized bilharzial infiltrations have to be differentiated from:

A. Intrinsic shadows in urinary tract,

FIG. 1. Case I. Showing cloudy appearance of the bladder, with bilharzial basal calcified contour on right side in a patient who did not complain of hematuria and where no eggs were discovered in the urine.

e.g., stones and tuberculous affections. Clinical examination and pyelography are helpful in the diagnosis of suspicious cases.

B. Extrinsic shadows:

1. In connection with intestinal tract—calcified or dense Houston's rectal valves, bilharzial mesenteric glands or calcified appendices epiploicae may throw shadows on the roentgenograms of the urinary tract which may be mistaken for urinary stones or for urinary bilharzial infiltrations.

In one case (see Fig. 30) opaque shadows simulating stones were seen in the course of one ureter in the roentgenogram of a patient complaining of severe renal colic. To me they seemed shadows of calcified glands in the abdomen owing to their irregular shape, irregular density and variable motility. The surgeon, however, being impressed by the complaint of the patient insisted that they were stones and the patient was operated upon, but no stones were discovered.

2. Calcifications in connection with uterus and its appendages.

3. Calcifications in connection with ligaments and blood vessels. The diagnosis is rendered clear by careful observations and study, by repeated roentgen examinations in various positions and under various circumstances and by pyelography.

CASE REPORTS

The following cases are given to support the views and observations made in this communication:

CASE I. (Fig. 1.) A. H. A. This case illustrates the cloudy bladder appearance which is seen in many cases of bilharziasis. There is a small right basal line in the bladder characteristic of bilharzial affection. This is a case of concealed infection.

Patient, aged twenty, admitted on March 9, 1930, complaining of left renal colic without definite history of hematuria or eggs in urine.

CASE II. (Fig. 2.) A. H. K. This case shows association of large stones with bilharzial bladder.

Patient, male, aged thirty-five, admitted to the hospital on February 6, 1930, complaining of pain in both loins for ten years and pain in perineum on walking; repeated attacks of renal colic with vomiting. The week before entrance,

FIG. 2. Case II. Showing large stones changing position in the bladder, which was the seat of bilharzial infection.

while passing urine the current was suddenly stopped and he was brought to the hospital for relief of retention of urine. No history of terminal hematuria but urine sometimes slightly colored. No ova discovered.

Roentgen examination showed two large stones changing their position in the bladder, one stone the size of a hen's egg and the other of a pigeon's egg. Another stone irregular, oblong-shaped about 7 cm. long seemed in the first roentgenogram to be in the lower part of the right ureter. In later roentgenograms it was seen in the bladder on the left side. The bladder showed a cloudy appearance due to chronic cystitis. A small basal calcified line was seen in the bladder and suggested bilharzial affection although no ova were discovered or hematuria complained of. Kidney contours not visible.

Patient refused operation and was discharged on February 12, 1930.

Case III. M. M. E. S. This is the case referred to in the text of mixed closed and open infections. Heavy calcified demarcations in bladder without cystoscopic findings. Figure 3 is a roentgenogram of the pelvis showing calcified contour and enormous calcified shadows in bladder due to deposition of calcified bilharzia eggs. Note the calcified patch at the lower end of the right ureter (calcified bilharzial papilloma). Figure 4 is a roentgenogram of the kidney region showing marked enlargement of the right kidney; the left kidney contour is not well seen in this figure. Figure 5 is a roentgenogram

Fig. 3. Case III. Roentgenogram of bladder showing calcified contour and enormous calcified shadows in the bladder due to deposition of calcified bilharzia eggs. No hematuria; no marked cystoscopic changes.

Fig. 4. Case III. Roentgenogram of kidney region showing marked enlargement of right kidney.

Fig. 5. Case III. Roentgenogram of post-mortem specimen of same case, showing bilharzial calcifications of the bladder, ureters and pelves of kidneys.

FIG. 6. Case III. Photograph of post-mortem specimens of urinary tract.

of the urinary tract of post-mortem specimen showing bilharzial calcification of the bladder, ureters and kidney pelvis, marked hypertrophy and hydronephrosis of right sectioned kidney which is more than double the size of the intact hydronephrosed left kidney. Figure 6 is a photograph of post-mortem specimen of the urinary tract. Figure 7 is a photomicrograph of the section of bladder showing deep deposition of calcified eggs without surface changes on the mucous membrane.

CASE IV. (Figs. 8 and 9.) S. A. S.

This is a case which illustrates advanced bilharzial lesions and calcifications in the bladder and ureters and increased density of the kidney tissues.

Patient, a Koran reader, aged forty, from the villages, admitted for pain in both loins and pubic region and painful difficult micturition of one year's duration. No vomiting during attacks; history of passing gravel and hematuria. General condition is poor and anemic.

Roentgen examination without pyelography showed definite calcified contour of lower and upper parts of the left ureter which is seen to be

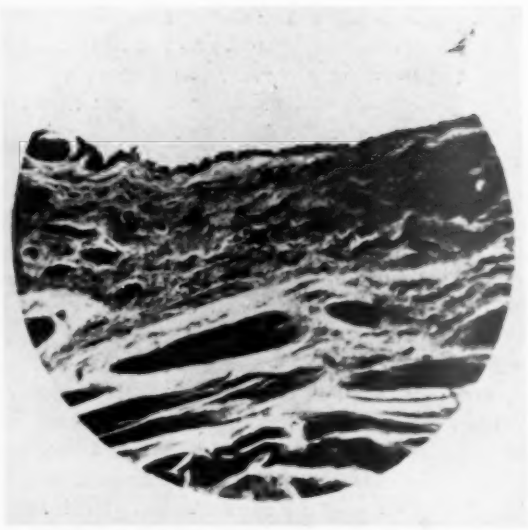

FIG. 7. Case III. Photomicrograph of section of bladder, showing deep deposition of calcified eggs without surface changes in the mucous membrane.

enormously dilated. The left kidney is dense and throws a heavy shadow on the roentgenogram and is definitely enlarged, its lower pole reaching down to the intervertebral space between the third and fourth lumbar vertebrae. The lower part of the right ureter is dilated and shows definite bilharzial linear contour demarcating heavy cloudy bilharzial appearance. The bladder shows heavy scattered bilharzial infiltrations in the form of calcified shadows. The ureteral orifices are certainly encroached upon by the bilharzial process in the bladder result-

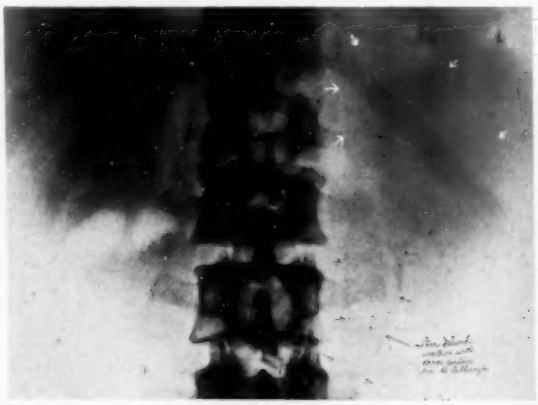

FIG. 8. Case IV. Roentgenogram before uroselectan injection, showing calcified bilharzial linear contour with dilatation of the left ureter and kidney pelvis.

Fig. 9. Case IV. Roentgenogram before uroselectan injection. Note marked calcifications in bladder and ureters, with dilated ureters due to involvement of ureteral orifices in the bilharzial process of the bladder.

ing in the dilatation of the ureters which can be well seen in the roentgenograms.

Case V. (Figs. 10 and 11.) A. A. E. H.

This is a case which illustrates the roentgen

Fig. 10. Case V. Roentgenogram before uroselectan injection. Note calcified bilharzial contour of bladder.

Fig. 11. Case V. Roentgenogram after uroselectan injection. The opaque material demarcates the pelves and upper parts of both ureters. No marked changes in kidney pelvis, although there is an enormous deposition of calcified eggs in the bladder (see Fig. 10).

evidence of bilharziasis and marked deposition of calcified eggs without marked damage to the urinary tract. The kidney pelvis and ureters are nearly normal as seen after pyelography.

Patient, a male farmer, aged twenty-three, has complained of recurrent attacks of renal colic for the last four months with vomiting and pain radiating to the testicles.

Past History. Terminal hematuria during the last two years with painful and frequent micturition. Patient passed a stone during the last attack.

Urinalysis. No ova detected; acid reaction; positive for red blood cells, pus cells, and albumin.

Cystoscopy. Bladder capacity 240 c.c. Pale colored mucous membrane but in some parts there are tortuous congested blood vessels and small, scattered, sandy patches with very few minute ulcerated areas. Left uretal orifice normal. Right ureteral orifice patent but slightly congested and lying in an area of sandy patches.

Roentgen examination showed definite bilharzial linear contour of bladder (Fig. 10) and enlarged left kidney, and a series of small calcified patches are easily mistaken for bilharzial infiltrations or stones. Fortunately, they disappeared in next series of roentgenograms and were therefore thought to be intestinal contents.

Uroselectan was secreted normally (Fig. 11). There is some dilatation of the upper part of the

FIG. 12. Case VI. Roentgenogram before uroselectan injection. Note bilharzial calcifications in the pelves of both kidneys and in ureters. Patient did not notice hematuria and did not complain of the usual symptoms of bilharziasis.

right ureter and kidney pelvis. The course of the ureters is well demarcated and they show no dilatation or tortuosity.

CASE VI. (Figs. 12, 13 and 14.) E. S. I. M.

This is a case free from hematuria and the usual symptoms of bilharziasis, and was sent to the roentgen department for a diagnosis of the cause of renal colic. Roentgenographically dense bilharzial calcifications were discovered, although cystoscopy showed few findings. It seems that the infection in the greater part was of the concealed type.

Patient, a policeman, aged twenty-five, admitted because of an attack of pain in the left loin three days ago lasting for three hours without vomiting or a radiation of the pain elsewhere. A similar attack occurred two years ago. No present or past history of difficulty in micturition, no visible hematuria, no history of passage of gravel.

Urinalysis. Few living and dead bilharzia ova on careful examination; pus cells, red blood cells, albumin, positive. Urea concentration 1.1 per cent; urea in blood 16 mg. per 100 c.c.

Cystoscopy by Dr. Abdel Hamid Fafez and myself. Bladder capacity 450 c.c. Fundus showed a few hemorrhagic areas. Right half of bladder was fairly normal with the exception of a few tortuous dilated blood vessels. The right ureteral orifice was normal and crescentic. The left ureteral orifice was patent, hollow, with papillomas around it, and occasional discharge of pus. Trigone was studded with scattered sandy patches and early papillomatous changes. There were few scattered calcified mottlings in the field.

Roentgen examination before uroselectan showed a dense calcified bladder and dilated calcified lower thirds of both ureters, dilated calcified pelvis of left kidney, dilated upper third of left ureter. Examination after uroselectan: The opaque substance was seen after fifteen minutes demarcating and outlining the tract. The pelves and calyces of both kidneys are dilated. There is a kink in the left ureter below the iliosacral synchondrosis and a definite bilharzial patch, probably a bilharzial papilloma, in the right ureter below the iliosacral synchondrosis. Both kidneys are enlarged.

CASE VII. (Fig. 15.) A. A. M.

Patient, a policeman, aged twenty-three, unmarried, admitted to hospital on October 30, 1930, complaining of pain in left kidney region shooting anteriorly towards the scrotum. History of repeated attacks of left renal colic for the last four years. History of passing gravel during last six months; took course of antibilharzial treatment in 1929 after which hematuria ceased, but attacks of renal colic continued.

FIG. 13. Case VI. Roentgenogram before uroselectan injection. Note heavy calcifications due to bilharzial infiltration of bladder and ureters, and cord-like appearance of ureters.

Urinalysis. Negative for ova and red blood cells.

Roentgen Examination. (1) Calcified bilharzial contour of bladder and lower part of right ureter; (2) stone oblong in shape (6 cm. long) in lower part of right ureter with bilharzial infiltration below it; (3) right ureter dilated and tortuous; (4) both kidneys enlarged in thickness.

Uroselectan was not seen in the bladder until forty-five minutes after injection, and did not demarcate pelvis of either kidney; shadows of kidneys were increased in density.

Operation on November 13, 1930. Stone in the ureter was removed and patient was discharged on December 1, 1930.

Case VIII. (Figs. 16, 17 and 18.) M. A.

This is a case free from renal colic but with a definite history of hematuria and showing roentgenographically bilharziasis associated with stones in various parts of the tract.

Patient, a chorus man, aged twenty-five, used to live in the villages near Tanta, admitted for painful micturition and mucus discharge from urethra for last three years. History of hematuria for six years, which stopped after antibilharzial treatment. History of gonorrhea with acute retention of urine. Painful and frequent micturition and mucus discharge continuing in spite of antigonorrheal treatment. No history of renal colic.

General condition good. Stone in bladder felt by sound.

Urinalysis. No ova. Positive for albumin, red blood cells, and pus cells. Negative for casts and sugar.

Fig. 14. Case VI. Roentgenogram after uroselectan injection. Note the marked dilatation of the pelves of the kidneys and ureters.

Fig. 15. Case VII. Note marked calcified appearance of bladder, with bilharzial infiltrations around the ureteral orifices; stone in lower end of right ureter in a patient complaining of left renal colic.

Urea concentration test:

	Volume c.c.	Percentage
Resting urine	38	1.2
1st hour	50	1.1
2nd hour	65	1.0
3rd hour	30	1.2
4th hour	135	0.9
Blood urea	12 mg.	per 100 c.c.

Cystoscopy by Dr. Hafez and myself. Bladder capacity 240 c.c. Bladder wall was normal with the exception of a small area of ulceration in trigone. Two stones were seen, one the size of a chestnut, the second the size of a bean, both whitish in color and smooth. Ureteral orifices normal in size but did not pass the dye after thirteen minutes.

Roentgen Findings. Stone in ureteral end of pelvis of left kidney and stone in one of the calyces with marked dilatation of pelvis and calyces of same enlarged kidney as shown after uroselectan injection (Fig. 18). The shadows of stones were suspicious of calcifications but pyelography helped to give idea of stones. Right kidney enlarged and nephroptosed. Stone in bladder the size of a shilling. Small stone in up-

Fig. 16. Case VIII. Note calcified contour of bladder, with a stone in bladder and another in the upper part of urethra. Definite old history of hematuria; no renal colic. Figure 18 shows stones in the kidney.

per part of urethra (pushed into bladder later on by cystoscopy). Definite bilharzial calcified linear contour of bladder.

Case IX. (Figs. 19, 20 and 21.) E. S. A. K. H.

This is a case to illustrate the association of bilharziasis with stones and the encroachment

Fig. 17. Case VIII. Roentgenogram before uroselectan injection. Note stones in the left kidney, although the patient did not complain of renal colic. Also note hypertrophy of right kidney.

Fig. 18. Case VIII. Roentgenogram after uroselectan. Note marked dilatation of pelvis and calyces of left kidney due to stone (S). Another stone (C) in one of the calyces.

of bilharzial manifestations of the bladder upon ureteral orifices, with dilatation of ureters and hydronephrosis.

Patient, aged forty, a workman in a village, admitted on June 8, 1931, complaining of painful micturition, without hematuria, for four years, occasional and temporary arrest of current of urine. History of stones of bladder extracted two and three years ago. He states that

Fig. 19. Case IX. Showing bilharzial bladder and stone. Note calcified lines in the bladder region.

Fig. 20. Case IX. After uroselectan. Note marked dilatation and tortuosity of ureters, stone and bilharziasis of bladder.

he passes mucoid material in urine. No pain in loins; for the last month he has felt some pain in the back. Frequency of micturition every half hour.

Urinalysis. No living ova, few dead ova. Albumin and pus positive. No sugar. Urea con-

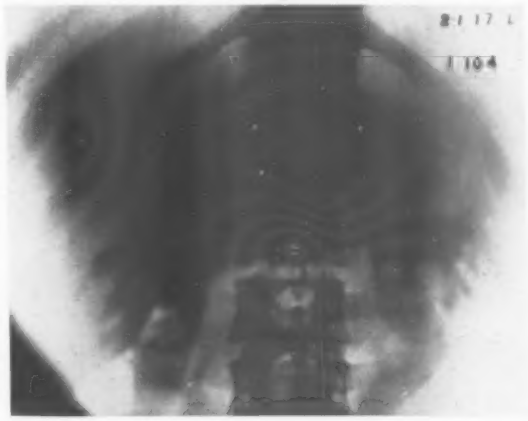

Fig. 21. Case IX. Roentgenogram taken after intravenous injection of uroselectan. Note extreme dilatation of ureters due to involvement of ureteral orifices with bilharzial infiltrations.

Fig. 22. Case X. Showing bilharziasis of seminal vesicles, ductus deferens and bladder. The series of films taken for this case show these parts outlined as if they were drawn from an anatomy picture of these organs. Note also a small stone in lower end of right ureter.

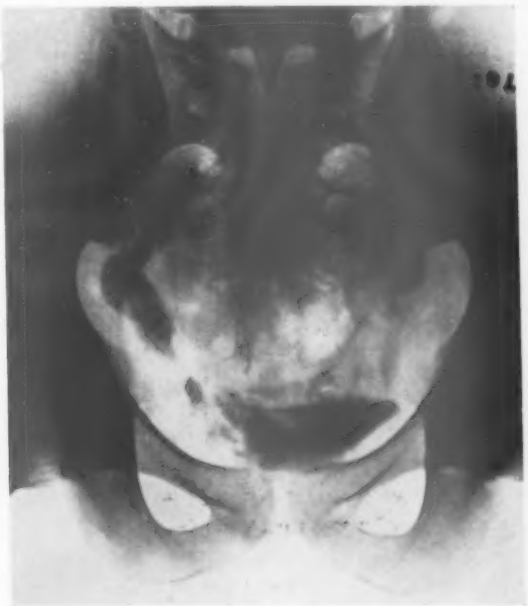

Fig. 23. Case X. After uroselectan injection. Note torsion of right ureter.

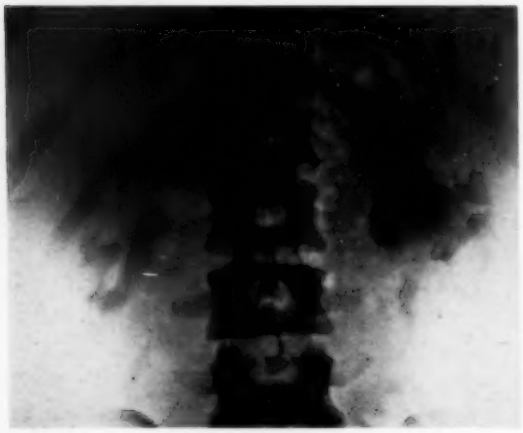

Fig. 24. Case x. Roentgenogram showing kidney region. Note marked dilatation of the renal pelves.

centration 0.8 per cent. Blood urea 27 mg. per 100 c.c.

Urea concentration test:

	Volume of urine c.c.	Percentage
Resting urine	35	0.8
1st hour	30	1.1
2nd hour	30	1.3
3rd hour	15	1.0
4th hour	25	1.1

Roentgen examination shows definite bilharzial calcified bladder zone. A large stone irregularly rounded, 4 cm. in diameter, in the bladder. Marked dilatation and kinking of both ureters and some dilatation of pelves of both kidneys as shown after injection of uroselectan, which is seen fifteen minutes after injection demarcating the whole urinary tract.

Operation. Suprapubic extraction of stone June 18, 1931.

Case x. (Figs. 22, 23, 24 and 25.) M. A.

This is a rare case where roentgen examination showed bilharziasis of the seminal vesicles and ductus deferens and bladder with a small stone in the lower end of the right ureter. The bilharzial calcifications are well marked. I have not seen a similar case before either in the reports of other authors, nor in my series of 1000 cases, unless similar cases have escaped my notice. The shadows may be mistaken for calcifications in bladder but careful examination of the series of films taken shows that the seminal vesicles and ampullae of the ductus deferens are as markedly outlined as if they were drawn from an anatomy picture of these parts.

Patient, unmarried sailor, admitted on July 2, 1931, complaining of pain in the right kidney region, not radiating elsewhere. The complaint started the day of admission lasting two hours and relieved by an injection of morphine. A similar attack occurred two years ago. No pain during or after micturition; no history of hematuria. Never received antibilharzial treatment. Erection perfect and power of copulation normal. Frequency of micturition four or five by day and nothing or once at night.

Urinalysis. Positive for bilharzial ova, hyaline casts, and pus cells with phosphatic deposits, acid reaction and trace of albumin.

Analysis of semen showed no bilharzia ova or red blood cells. Sperms living, active, and of enormous quantity.

Cystoscopy. Congested mucosa of bladder with fine sandy patches and few papillomatous formations. Normal ureteral orifices. Base of bladder shows some engorged blood vessels. Capacity of bladder 400 c.c.

Roentgen examination reported above. In addition both kidneys are hypertrophied and hydronephrosed as seen after uroselectan injection. The stone in the lower end of the right ureter seems to be a causal factor of the changes in right ureter, pelvis of the right kidney and calyces.

Fig. 25. Case x. Roentgenogram taken after injection with uroselectan.

A definite bilharzial infiltration is seen in lower part of left ureter. This may be a sessile or pedunculated calcified papilloma obstructing the lumen of ureter and causing enormous dilatation of left ureter, pelvic kidney and calyces.

Case xi. (Figs. 26 and 27.) A. G. M.

This is a case which illustrates superimposition of tumors over an old bilharzial infection. Figure 26 shows bilharzial calcifications in the bladder area. Figure 27 is a cystogram taken after injecting sodium iodide solution into the bladder. This shows marked filling defect on left side of the bladder due to tumor formation.

Patient, a farmer, aged fifty, admitted to the hospital on July 12, 1930, for painful micturition with occasional retention of urine and difficult painful defecation for two months.

The patient was operated upon as an emergency case and suprapubic cystotomy was done to relieve retention before the surgical wards received the roentgen report.

Case xii. H. A. R.

This is a case of double left ureter discovered accidentally during pyelography made after uroselectan injection for bilharziasis or tumors.

Patient, a farmer, aged thirty-five, admitted on October 14, 1930, complaining of pain in

Fig. 26. Case xi. Before injection of opaque solution. Note dense shadows in bladder due to bilharzial infection. Malignant disease was detected later after cystography.

Fig. 27. Case xi. Shows filling defect on left side of bladder due to malignant disease of bladder which is superimposed on chronic bilharzial infection. Roentgenogram taken after injection of opaque solution.

right lower part of abdomen of one year's duration. Patient stated that the pain began in the epigastrium and passed to the left loin and later to the right loin and remained stationary in the right side up to time of admission. No vomiting or fever.

Patient was operated on, on October 29, 1930, for removal of suspicious appendix.

Case xiii. N. H.

Patient, a female, admitted to hospital in October, 1930, for incurable vesicovaginal fistula. One of our surgeons (Dr. Riad Iskander) made a ureteral implantation into the upper part of the rectum. He contemplates doing such an operation in cases of advanced bilharziasis or cancer of bladder and prostate.

Retrograde pyelography was done after injecting 6 c.c. of 20 per cent sodium iodide solution in each ureter through the catheters passing in the artificial ureteral openings into the rectum. Both catheters are included in a rubber tube introduced into the rectum. The course of both ureters was seen and the pelvis of each kidney was demarcated.

SUMMARY

Bilharziasis is a disease worthy of consideration and study in Egypt as it affects about 70 per cent of the population. Serious complications may follow bilharzial urinary affections. Roentgen examination reveals the infection when there is sufficient deposition of calcified eggs. Roentgenography, especially pyelography, helps to demonstrate complications, e.g., strictures, tortuosity or sacculation of ureters or urethra, hydro- or pyonephrosis, lithiasis, fistulae, papillomata, or malignant tumors.

Intravenous pyelography is simpler and is preferred to the retrograde method in most cases, as bilharzial complications often prevent the use of the cystoscope or ureteral catheters.

Roentgenographically, bilharziasis reveals itself in the form of calcified demarcations or cloud-like shadows in any part of the urinary tract. The former are pathognomonic; the latter are suggestive of the infection.

Surgeons and physicians often ask whether these calcified lines or patches can be produced by any other disease. The only absolute proof that bilharziasis is the causal factor was offered by microscopic examination of post-mortem specimens and demonstration of calcified eggs in areas where the roentgenograms showed calcified demarcations.

Calcified demarcations are often discovered in patients who never complained of the usual clinical manifestations of bilharziasis, e.g., hematuria, and ova in the urine.

In the light of recent investigations these patients are considered roentgenologically to be bilharzial subjects, although clinically there is no evidence of the infection. Roentgen examination in such cases is the only method of discovering the infection during life.

These so-called cases of "concealed infection" may be cases of old, healed, open bilharziasis who did not notice the hematuria, or may be cases of what may be called "closed bilharziasis" where the eggs are deeply deposited in the walls of the affected organs and do not succeed in penetrating to the mucous surface.

Tables I and II show the result of analyses of 300 cases. The extent of distribution of bilharzial lesions and calculous formations in various parts of the urinary tract is given.

In 143 cases of stones: 17.5 per cent were found in kidneys; 25.8 per cent in ureters (upper part 6.7 per cent, middle part 3.5 per cent, lower part 21.6 per cent), 58 per cent in the bladder, and 0.7 per cent in the urethra.

The differential diagnosis is illustrated in the text.

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SOME UNUSUAL CHANGES IN THE LESSER TROCHANTER OF THE FEMUR*

A REPORT OF TWO CASES

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THE center of ossification of the lesser trochanter of the femur appears at eight to ten years of age. Fusion usually takes place at eighteen years of age. It is quite unusual to see any change in the lesser trochanter. The change that has been most frequently described is avulsion of the lesser trochanter. Fracture may occasionally take place through the lesser trochanter, and sometimes ossification of the tendon of the iliopsoas muscle is noted. Müller noted an irregularity in the lesser trochanter which he interpreted as an epiphysitis. This change, while it may occur, is doubtful in this particular case, and Altschul pointed out that similar changes might be artificially produced by alteration of the projection angle of the penetrating ray. Buchman described an epiphysitis of the lesser trochanter in a patient with multiple epiphyseal involvement. Groves observed that the lesser trochanter might bear a facet for articulation with the outer surface of the ilium in congenital dislocation of the hip. Broadening and increase in size of the lesser trochanter, with or without more or less sharply delineated translucent areas, may occur in dyschondroplasia. Inflammation or tumor may possibly affect the lesser trochanter, primarily or secondarily. Geschickter stressed the fact that primary chondrosarcoma occurred characteristically at the junction of tendon to bone, and although the lesser trochanter is not a site of predilection, it still may be affected.

Two cases are reported in each of which the lesser trochanter of the femur presented an unusual change.

CASE 1 (B4054). A girl, aged fourteen, complained of a dull, heavy, aching sensation in the anterior and inner aspects of the left hip. The pain was greatest at night and was relatively slight during the day. Symptoms had been present for three months and had not been occasioned by injury. No fever had been present but the patient had lost 16 pounds in weight during her illness.

The patient, a tall, slender girl, complained of no pain on palpation over the region of the greater trochanter. Pain was definitely elicited by palpation in the region of the lesser trochanter. No swelling was present. The motions of the left hip were slightly limited in flexion and internal rotation. When both hips were flexed on the abdomen, and extension against resistance of the left flexed thigh was attempted, pain was experienced in the region of the lesser trochanter at the insertion of the iliopsoas muscle. She walked without limping. Blood Wassermann and skin tuberculin tests were negative.

A roentgenogram taken three weeks before admission to the Out-Patient Department of the Hospital for Joint Diseases revealed the following interesting change (Fig. 1). The lesser trochanter was enlarged and showed a hazy, indefinite contour. The trochanter presented many areas of rarefaction, surrounded by areas of condensation, much as one sees in epiphysitis. The base of the trochanter was thickened and sclerotic and presented two areas of rarefaction in the region of marked sclerosis. The width of the cortex was increased at this point, and its inner, marrow-facing surface was somewhat irregular. The hip joint showed no change and the femur was otherwise normal.

Another roentgenogram was taken at the time of first visit (Fig. 2). This revealed the surprising fact that reconstruction of the lesser trochanter had taken place within a period of three weeks. The contour of the lesser trochanter was normal and there was a normal internal configuration, with no areas of rarefaction or condensation. The base of the lesser trochanter still presented some cortical scle-

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rosis of much lesser degree than previously noted. An area of resorption was present on the inner aspect of the cortex.

Extension against resistance was not painful three weeks after her initial examination.

It is apparent that we are dealing in this case with a transient disease process which is most probably of a low grade inflammatory nature. The changes within the trochanter proper are those usually considered indicative of an epiphysitis; yet the extension of this process to the subjacent bone bespeaks an inflammatory origin. Miller has described a transient suppurative epiphysitis of the hip joint which is manifested by slight symptomatology and transiency. This case most probably falls within that group, save in location of the disease process.

Case II (16010). A woman, aged thirty-five, was admitted to the Out-Patient Department of the Hospital for Joint Diseases on September 10, 1931, because of an old, untreated congenital dislocation of the left hip. The roentgenogram (Fig. 3) showed the dislocation of the left hip clearly. The lesser trochanter was definitely enlarged and faced the primary acetabulum. The contour of the lesser trochanter was that of a truncated cone, irregular on its superior surface. The normal semicircular outline of the lesser trochanter was lost. Inferomesially, a grooving of the trochanter was seen. The base of the trochanter was normal.

Fig. 1. Case 1.

Fig. 2. Case 1.

There is no reason to suspect that we are dealing with dyschondroplasia or with tumor. Whether this change in the lesser trochanter is secondary to the long continued flexion and adduction of the congenitally dislocated hip is uncertain. There seems to be no faceting of the lesser trochanter and this is rendered unlikely by the distance between the lesser trochanter and the ilium. An anomalous fibrous band has evidently grooved the lesser trochanter.

FIG. 3. Case II.

FIG. 4. Reduplication of the lesser trochanter of the femur, a simple anatomic anomaly.

I wish to express my thanks to Dr. M. Pomeranz for his kindly criticism of the paper.

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Vol. XXXI No. 2

ORAL CHOLECYSTOGRAPHY*

A PLEA FOR A UNIFORM TECHNIQUE

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CHOLECYSTOGRAPHY is now well recognized as an established method for investigation of gallbladder affections. Inasmuch as the technique employed in the oral procedure is extremely variable, the results are consequently by no means uniform. It must therefore be apparent, that if a more uniform standardized technique were universally adopted, a much higher percentage of satisfactory cholecystograms would be observed. Excellent shadows of the gallbladder may be obtained by the use of the oral method, but unfortunately the results have not been constant. The most important cause for this variation is due to the administration of an insufficient amount of dye. In this communication I am presenting the technique which we have employed as one which has given a maximum of uniform results.

We have frequently maintained that the oral dosage of tetraiodophenolphthalein, generally administered, has been inadequate for the average patient. Inasmuch as the dye must pass through the stomach and into the intestines, where it becomes absorbed and then excreted by the liver into the gallbladder, some allowance must be made for a certain amount of unabsorbed dye as well as for certain chemical changes which may occur in the digestive tract. The quantity of dye which is absorbed and excreted is not uniformly alike in all individuals. While a small dose of dye may be sufficient for one individual, the same quantity of the drug administered to another of the same weight may be quite inadequate. Ordinarily the dye is packaged in 3 and 3.5 gram bottles, which is recommended as an adequate dose for the average patient for oral cholecystography. According to our experience this dosage is rather small for routine purposes and should be increased so that the oral test can be made more dependable.

In intravenous cholecystography the dosage recommended varies between 2 and 3 grams. The full amount of dye passes through the blood stream without any chemical change and is finally excreted by the liver into the gallbladder. The small dosage employed in this procedure is therefore quite adequate to produce uniform and satisfactory cholecystograms. There is no doubt that the intravenous test is the more accurate, but the oral method is best for routine studies and yields excellent results in nearly as high a percentage of instances, if the proper technique is employed. It is hardly possible to expect to obtain as good results by administering 3 grams of the dye orally, when almost the same quantity is administered intravenously. In a study of the literature, we find that the distributers of the drug as well as roentgenologists have ordinarily advocated the minimum dosage for oral use. It is quite true that satisfactory cholecystograms may frequently be obtained with a small dosage of the dye, but our experience has shown that uniform gallbladder shadows are not always obtainable under these conditions.

In 1926[1] we advocated a uniform technique with a maximum amount of dye given orally in order to produce better cholecystograms. We also directed attention to the fact that the test must be simplified so that it can be carried out with greater ease. We[2] later studied the effect of tetraiodophenolphthalein on dogs and found that the dye had no deleterious effect upon the liver or kidneys. In a collective study[3] of 18,000 cases in which the oral

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administration of tetraiodophenolphthalein was used, it was pointed out that there was little or no toxic effect as the result of the use of this drug. In 1928[4] four factors were stressed which accounted for many of the difficulties encountered in securing a uniformity in oral cholecystography. These were: (1) improper technique, (2) insufficient dosage, (3) faulty interpretation, and (4) improper cooperation of the patient. In a more recent report[5] of 500 cases of oral cholecystography we again stressed the necessity of a simple technique and advocated a maximum dosage of tetraiodophenolphthalein.

During the past year we have utilized a technique by means of which a uniform density is obtained almost comparable to that resulting from the intravenous method. The cholecystograms were therefore greatly improved over those formerly obtained. The density of the gallbladder shadow is a striking feature. Better diagnostic gallbladder films are procured as a result of this uniform standardized roentgen technique. There are three main factors with which we are concerned in order to secure uniform cholecystograms. These are: (1) meticulous technique, (2) maximum dosage, (3) greater personal attention of the roentgenologist.

TECHNIQUE

The following technique is routinely employed for oral cholecystography:

The patient is allowed to have the usual breakfast. A light non-fatty meal is advised for lunch. From one to two hours after this meal the patient is given a single dose of tetraiodophenolphthalein. It is important that the dye should be administered by the roentgenologist or by someone under his supervision, inasmuch as some patients do not take the full dose when they are permitted to administer the dye themselves. No food is allowed after the dye is administered, but water may be permitted at all times. One or two small glassfuls of orange juice or grape juice may be taken at any time on the day the dye is administered. Following the administration of the dye, the patient is advised to lie on the right side for one hour. This is, however, of minor importance, especially when the liquid dye is given. The patient is then instructed to return for the roentgen examination the following morning, when a series of eighteen hour cholecystograms are obtained. If the gallbladder is not visualized at this time, the examination is completed. When the gallbladder is filled, four or five films are taken, both during inspiration and expiration. If these are satisfactory the patient is then given an egg milk shake and one or two roentgenograms are made one hour later in order to note the contraction of the gallbladder. It is noteworthy that following the administration of the dye only one visit is required to complete the test. It is not usually necessary to see a patient four or five times during the routine procedure. This simplified method is quite satisfactory in the majority of instances. Occasionally it is necessary to make additional examinations.

Besides the usual routine procedure, it becomes necessary at times to take roentgenograms in different positions in order to eliminate overlying shadows. The elimination of gas shadows which may simulate negative stones often requires painstaking care. The opaque dye shadows in the colon must also at times be eliminated from the gallbladder. Shifting the gallbladder in different respiratory phases or rotating the body in order to secure an oblique view will often aid in eliminating extravesicular shadows. We usually prefer to give a cleansing enema an hour or two before the gallbladder examination is made. This procedure will often aid in removing the gas and opaque dye from the bowel and thus permit of better roentgenograms. If the gas shadows cannot be eliminated from the colon, we have found that if the bowel is completely filled with water and a roentgenogram made before it is expelled, extravesicle colonic gas shadows may be eliminated more satisfactorily. The elimination of gas shadows in the duodenal area is

more readily secured by the oral administration of water. These details are roentgenologic problems and one cannot rely on the average technician to perform them properly unless under constant supervision.

Dosage. Since we have found that 3 grams of tetraiodophenolphthalein is insufficient for uniform cholecystography, we have had 6 gram bottles of the powdered drug prepared. The 6 gram dose is used for the average patient. Even in thin adults we now advocate this minimum dosage. For obese patients the dose can be increased up to 9 grams, depending upon the size of the abdomen. The dye is administered in a single dose. Inasmuch as we now know that the dye is harmless even when administered in large doses, the larger dosage which we recommend should be given in order to obtain better cholecystograms and at the same time to eliminate the error of obtaining a non-filling gallbladder which may be due to an inadequate amount of the drug. It is therefore apparent that the most important doubtful factor in oral cholecystography is excluded as a result of the increased dosage. To illustrate the importance of the proper dosage, I could cite a number of instances in which the gallbladder failed to become visualized following the administration of 3 grams of tetraiodophenolphthalein, but when the test was repeated with a 6 gram dose, an unusually dense normal gallbladder shadow was obtained. During the past few years we have repeatedly noted an absence of the gallbladder shadow or a faint shadow in many instances, due to an insufficient amount of dye.

It is interesting to note that in a series of 100 carefully studied cases in which the 6 gram single dose was given, but slight disturbance as the result of the dye was noted. It has been our experience that vomiting is not produced more often as the result of the larger single dose. We have found in most instances in which nausea and vomiting are prominent symptoms, that these patients are not infrequently subject to such complaints. Since employing the single large dose our experience has shown that we are no longer confronted with untoward reactions in the majority of instances and that the few reactions we have encountered were of minor importance. Nausea and vomiting were lessened to a remarkable degree. Diarrhea was complained of in but few instances.

According to our experience the reliability of oral cholecystography has been greatly improved and the percentage of correct diagnoses has been increased as a result of the better cholecystograms obtained by the technique described.

SUMMARY

The importance of employing a standardized technique which has been found to give reliable cholecystograms is pointed out. The painstaking care which this test requires in all its details has been described. A simplified, routine, uniform technique cannot be too strongly emphasized in order to minimize the possibilities of roentgenologic errors. The increase in the average dosage to 6 grams of tetraiodophenolphthalein is necessary to obtain uniform, dependable results. This increase in dosage does not in any way produce untoward effects. The density of the gallbladder shadow obtained by the oral procedure is almost equal to that obtained by the intravenous method.

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ROENTGENOLOGIC DIAGNOSIS OF PLACENTA PREVIA*

REPORT OF A CASE

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THE DIAGNOSIS of placenta previa still represents a difficult problem. The clinical symptoms and physical findings are often indeterminate. Williams[4] states that it may even be necessary to dilate the cervix manually and by the insertion of a finger determine whether placenta previa is present. Although such a procedure might bring on premature labor, he considers the risk "justifiable, since we possess no other means of arriving at a definite diagnosis, which should be made at any cost on account of the very serious menace which the existence of the condition offers to the life of the patient."

The only successful roentgenological demonstration of the placenta was first described by Menees, Miller, and Holly.[2] They injected a solution of strontium iodide through the anterior abdominal wall into the amniotic sac, thus changing the amniotic fluid into a contrast medium in which the placenta was visualized as a filling defect. In this way the location of the placenta can be accurately defined. In one of their cases of placenta previa, at the sixth month, the fetus was expelled about thirty hours after the injection, with evidences to indicate that the injection had been made through the placental region. Kerr and Mackay[1] tried this method in 10 cases, but discontinued it, as the fetus died in 3 of the cases. They then substituted a derivation of iopax, which is nontoxic and nonirritant, for the strontium iodide. In 10 cases in which this procedure was followed, no untoward effects occurred to either the fetus or the mother, though the injection had a great tendency to terminate the pregnancy.

We are presenting herewith a detailed study of a case which indicates that a more simplified procedure can lead to the correct diagnosis of placenta previa. In our case the analysis was made from the usual anteroposterior film of the abdomen and pelvis. In later cases studied by two of us (Urner and Ude) at the Minneapolis General Hospital, we have improved the method by the instillation of a small quantity of sodium iodide into the urinary bladder. This allows the accurate identification of the contour of the bladder and forms the key for the identification of a low implantation of the placenta.

CASE REPORT

Mrs. F. M. O., a white woman, aged twenty-seven, was admitted to St. Mary's Hospital May 2, 1932. Her last menstrual period had occurred October 1, 1931. About one month ago she developed a severe hemorrhage which subsided under bed rest. During the past week hemorrhage recurred on two occasions, but responded to treatment. The physical examination revealed a pregnancy of about seven months' gestation. The head of the fetus was located in the right lower quadrant, with the back directed to the right. The placental bruit was heard most distinctly in the left lower quadrant. On rectal examination the cervix was soft and edematous. A pulsation could be distinguished in the left lower pelvis from a boggy mass continuous with the uterine mass. Vaginal examination revealed a slight bleeding from the cervix. The clinical picture therefore indicated the presence of placenta previa.

The patient was referred for roentgenological examination on May 6, 1932. The anteroposterior film of the abdomen (Figs. 1 and 2) revealed a normal fetus of about seven months' gestation. The head was overlying the right half of the lesser pelvis. The back of the fetus was directed toward the right. A study of the lesser pelvis revealed two definite soft tissue

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masses. One of these masses presented the typical appearance of a partially filled urinary bladder, with a crescentic pressure defect on its upper surface such as is typical from an enlarged uterus. The second mass, also crescent shaped, rested in the defect of the bladder, was approximately 1 inch in diameter in its widest portion, and tapered off toward both ends. This second mass was interposed between the head of the fetus and the bladder, and was in close relationship to the head of the fetus. This mass was interpreted to be the placenta. Because of its location low in the lesser pelvis, and its interposition between the fetus and the urinary bladder, a roentgenologic diagnosis of placenta previa, probably of the central type, was made.

Cesarean section was done by Weum on May 10, 1932, with delivery of a living baby girl lying in occiput right anterior position. The placenta was found to be implanted in the lower uterine segment overlying the opening of the cervix uteri and was packed into the cervix from which it was removed with a moderate degree of difficulty. The operative findings corresponded in every detail with those of the roentgenologic examination.

Fig. 1. Roentgenogram of single pregnancy with upward displacement of the fetal head by a pelvic mass (placenta previa). See Figure 2 for diagram of these findings.

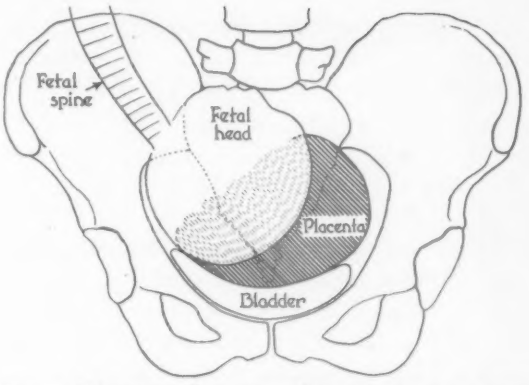

Fig. 2. Diagram of roentgenologic findings in a case of placenta previa shown in Figure 1.

DISCUSSION

We are presenting the above detailed report to illustrate the roentgenologic findings in placenta previa, and to support the supposition that these findings permit the roentgenologic diagnosis of this condition without actual invasion of the uterine cavity. The first factor in the analysis of a case of this type is the accurate identification of the urinary bladder. In this case it was clearly defined without contrast medium. As stated above, we have found it very helpful, in subsequent cases, to inject a small quantity of sodium iodide solution into the bladder, so that its margins can be more clearly visualized. The second analytical factor depends on the anatomic relationship between the pregnant uterus and the urinary bladder. In the late stages of pregnancy the lower uterine segment consists of a thin-walled muscular tube, measuring only a few millimeters in diameter. The anterior portion of this segment lies in direct contact with the posterosuperior margin of the urinary bladder, separated from it only by the reflection of the peritoneum. Therefore, if the head of the fetus lies in the lower uterine segment, its bony outline should be separated from the outline of the bladder only by the thickness of the uterine and bladder walls and by the thickness of the fetal scalp. In subsequent control cases studied by Ude and Urner at the

Minneapolis General Hospital, this relationship of the fetal head to the maternal urinary bladder was found to be a constant one. This was also substantiated by Drs. John S. Lewis Jr. and Edgar C. Baker in their scientific exhibit at the meeting of the Radiological Society of North America at Atlantic City. They showed a series of pregnancy cases studied by means of intravenous pyelography to demonstrate the nature of hydronephrosis complicating pregnancy. This contrast medium gave a clear visualization of the urinary bladder, and demonstrated as a constant finding the above described relationship. The third analytical factor depends on the interposition of a soft tissue mass between the fetal head and the urinary bladder, producing a corresponding elevation of the head from the lesser pelvis. The contour of this mass should correspond to that of the placenta. It will at once be apparent that this analysis presupposes the presentation of the head in the lower uterine segment. If a breech or transverse position is present, these findings cannot be established.

The presence of placenta previa having thus been established, the size and position of the demonstrable mass may aid in arriving at an opinion as to the variety of the implantation. It is probable that whenever this condition is thus found, the implantation is sufficiently low to indicate either the central or the partial type. In our case the presenting mass was sufficiently large to suggest the central type.

By means of these diagnostic features, two of us (Urner and Ude) were able to demonstrate placenta previa in two additional cases, both of which were later substantiated at the time of delivery. The findings in these two additional cases varied only slightly from those described above, and presented no other diagnostic features.

We have also studied a case of premature separation of the placenta in which there was the question of differentiation from placenta previa. In this case we found a very high position of the head of the fetus with a rounded mass measuring about 10 cm. in diameter interposed between the head and the urinary bladder. Our impressions, before delivery, was that this was not placenta previa. The findings at delivery were those of premature separation of the placenta. It is probable that a wider study of cases of this type will develop definite criteria for the establishment of this differentiation.

In offering this as a preliminary report, we recognize that further experience with the method may modify our interpretation of the roentgen findings. We believe that a larger series of cases should be studied to establish the normal findings in each of the last four months of gestation. The changes produced by adnexal masses[3] must also be kept in mind, and these must be differentiated from those produced by placenta previa. Undoubtedly other difficulties in differential diagnosis will arise as we find opportunity to study more cases of this condition. However, we feel that the method is giving us a decided aid in arriving at a definite conclusion when this condition is suspected clinically.

SUMMARY AND CONCLUSIONS

1. A case of placenta previa is reported in detail, in which the presence of the condition was determined roentgenologically without the aid of contrast material, and without invasion of the uterus. The roentgenologic findings are analyzed. The additional use of a contrast medium in the urinary bladder is advised.

2. Two additional cases of this condition which were diagnosed by this method are briefly reported.

3. A case of premature separation of the placenta was also demonstrated roentgenographically.

4. This method of study is advocated as offering a satisfactory diagnostic aid in the differentiation between placenta previa and accidental hemorrhage.

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RADIOSENSITIVE NEUROBLASTOMA*

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NEUROBLASTOMA, better termed by Bailey and Cushing,[1] sympathicoblastoma, has usually been reported because of its rarity as a clinico-pathologic entity. Few cases have been reported ante mortem, and, as a consequence, little attention has been paid to the treatment of the disease. More recently the diagnosis has been established clinically and by means of biopsy. Roentgen diagnosis has also been proved to be of value by Holmes and Dresser,[7] Sturtevant and Kelly,[16] Henle[6] and Karelitz.[8] They have found metastatic evidence of neuroblastoma in roentgenograms of the skeletal system. Cushing and Wolbach,[3] as well as Holmes and Dresser,[7] were able to establish the diagnosis of this disease by means of biopsy.

In 1917 Lehman[10] reported the first patient successfully operated on and living after two and a half months. He states that "all other patients that have come to operation have died during or shortly after the operative procedure." In March, 1932, the same author[11] reported the patient living and well—a fifteen-year cure. Cushing[3] removed a ganglioneuroma, a benign type of sympathetic nerve tumor, from the paravertebral region at the level of the sixth dorsal vertebra which had been treated previously with Coley's toxins. Ten years before removal a biopsy revealed a sympathicoblastoma. The change in type of growth was attributed to the use of toxins. Two of the 4 cases reported by Scott, Oliver and Oliver[15] were subjected to surgical measures. Radiation therapy has been used on patients reported by Boyd,[2] Kwartin and Twiss,[9] and Holmes and Dresser.[7] In each instance the progress of the disease was not altered. Gibson,[5] in a systematic report on adrenal tumors, says that "in inoperable cases deep roentgen-ray therapy deserves a trial, although no statistics are available as to its efficacy."

The following case report clearly demonstrates that this type of tumor is radiosensitive. Although the patient died of recurrence, radiation therapy may prove to be of value in future cases.

FIG. 1. Anterior view of neck showing large tumefaction on left side. May 27, 1932. Before irradiation.

REPORT OF CASE

J. P. (Case No. 44867), a white boy, aged five, was admitted to Memorial Hospital on May 20, 1932, with the complaint of enlargement of the right neck region (Fig. 1). Two months previously, the original swelling had appeared in the left parotid and submaxillary regions. Medical and "electrical" (possibly ultraviolet irradiation) treatments had been given elsewhere. Physical examination revealed a five

* From the Medical Service of Dr. Lloyd F. Craver.

year old boy in good general condition except for the local lesion. The tonsils were somewhat enlarged. The neck showed diffuse bilateral enlargement of the submaxillary lymph nodes. The subcutaneous tissue of the left cheek contained a small nodule, and the left posterior cervical triangle contained a chain of palpable nodes. There was evidence of recent treatment to the neck resulting in tanning of the skin. On May 23 a biopsy was taken from the swelling in the left cervical region.

Report of biopsy by Dr. F. W. Stewart:

Gross: Mass of tissue 1.5 cm. in diameter. Section reveals homogeneous mass of white opaque material.

Microscopic: A lymph node metastasis. The tumor consists of solid sheets of small, elongated ovoid cells with a large nucleus, about twice the size of a small lymphocyte, and scanty cytoplasm. True rosettes are not apparent, but there are rosettes in the sense of a palisade of nuclei about a central radiating aggregation of fibrils. There are, nevertheless, numerous large, pink staining, faintly opaque, vacuolated, cytoplasmic masses of varying size scattered throughout the tumor. In many of these masses

Fig. 2. Swelling on left side has largely disappeared following irradiation. June 13, 1932.

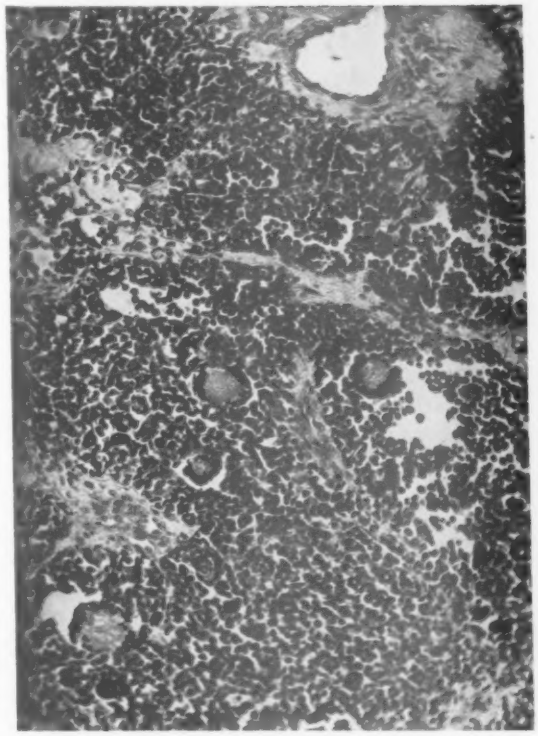

Fig. 3. Photomicrograph showing involvement of cervical lymph node.

it is possible to detect degenerated and swollen nuclei. It is possible to trace the origin of these cytoplasmic aggregates to cytoplasmic syncytia containing from two to three and up to many fused tumor cells. In the fully developed syncytial masses the central cells have degenerated leaving a mass of regularly and irregularly distributed peripheral nuclei. The position of the nuclei indicates that terminal fibrillae from these cells do not make up the central conglomeration. Many of the peripheral nuclei are undergoing pycnotic degeneration with leucocytic invasion. The tumor seems to be a neurocytoma (sympathicoblastoma). The large cytoplasmic aggregates may indicate a tendency to formation of ganglion cells. It probably arose in the cervical sympathetics, although attention should be directed to the adrenals. It is extremely malignant and highly radiosensitive (Fig. 3).

No abdominal mass could be found on closer examination. Both testes were situated in the inguinal canals. Roentgenograms of the chest on May 20 showed extensive pulmonary metastases (Fig. 4). On the 2d and 3d of June, 750 r or high voltage roentgen therapy was given to

the right and left neck regions respectively. On the following day roentgen therapy to the chest was started, giving 500 r daily until 1000 r was administered to each of four portals. On June 13 the neck masses had largely disappeared (Fig.

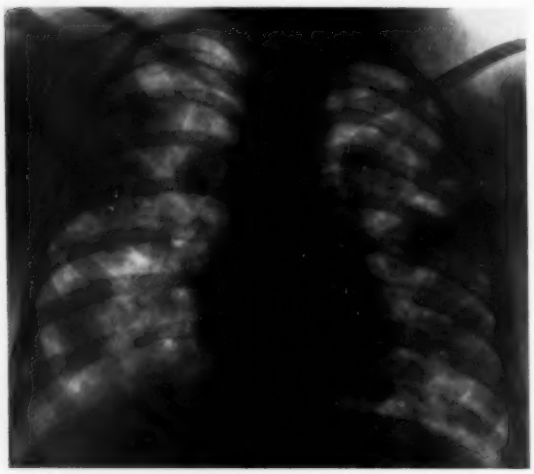

Fig. 4. Roentgenogram of chest showing extensive pulmonary metastases.

2) and the chest film showed a considerable clearing of the metastases. The patient was discharged from the hospital and was next seen in the clinic on June 27 because of pain in the right groin and front of thigh and a limp of the right leg. At this time there was good regression of the masses in the neck with the exception of the left submaxillary region which apparently escaped irradiation. The chest roentgenogram showed complete disappearance of the lung metastases (Fig. 5). Roentgenograms of the pelvis taken at this time revealed destructive lesions in the right ilium, symphysis pubis and upper end of the right femur which were interpreted as metastases. The right pelvic region was irradiated anteriorly, laterally and posteriorly, using 700 r to each field. The left submaxillary region was also given 700 r of high voltage therapy. Improvement was noted following these treatments. On July 12 a small nodule was noted in the left parotid region. During the latter part of the same month the patient was readmitted to the hospital because of increasing dyspnea, pain in the right hip and complete loss of appetite. Fine râles were detected throughout the right lung and tubular breathing and dullness over the left lung. Roentgenograms showed return of extensive metastases throughout both lung fields. The temperature and pulse were consistent with a bronchopneumonia. Two roentgen treatments of 500 r each were given to the chest, but owing to the increased severity of the symptoms no more radiation was given. On August 18 the patient looked quite ill. Small firm nodules in the left supraclavicular region were increasing in number. A new mass 2 cm. in diameter appeared in the left cheek and in the left parietal region of the scalp. Death took place two days later.

Owing to the failure to receive permission for autopsy, the primary site of the tumor was uncertain. Most of the reported cases had their origin in the medulla of the adrenal gland. Since no abdominal mass could be found in the above described case, it was reasonable to assume that the primary site could have been in any part of the body other than the adrenal glands. The cervical sympathetics would be a logical site to assume since the tumor mass was first noticed in the neck. Martius[12] reported such a case in 1913. Boyd[2] states that theoretically, a neuroblastoma may arise wherever neuroblasts are found. In Symmer's[17] case the tumor appeared in the scapular region. Ewing[4] mentions one which

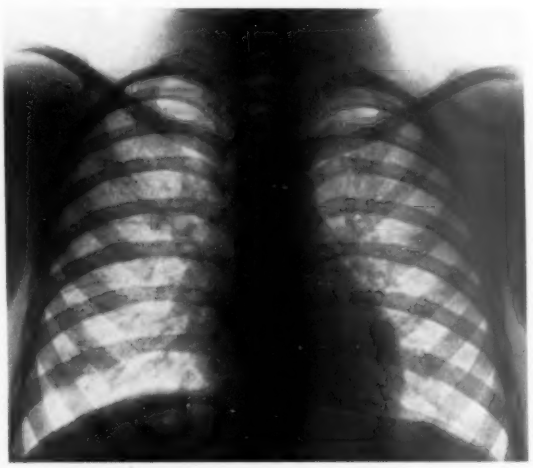

Fig. 5. Roentgenogram of chest showing disappearance of metastases following external irradiation.

originated in the femoral sympathetic plexus. Other reported locations are in the paravertebral region (Henle;[6] Cushing and Wolbach[3]), intrathoracic region (Scott and Palmer[14]), and in the jejunum (Ritter[13]).

The dosage factors used in the radiation therapy were 200 kv., 30 ma., 0.5 mm. Cu filtration, 50 cm. target-skin distance for the neck and pelvis, and 70 cm. for the chest.

COMMENT

The patient's disease was advanced at the time of admission. Earlier recognition and earlier radiation therapy would possibly have given the patient a better prognosis or perhaps a cure. The irradiation technique employed was of the massive dose type. It is possible that small, divided doses extended over a period of several weeks with a greater total dosage would have brought about permanent regression. Only the future will determine which type of radiation therapy is the better now that it is known that neuroblastomas are susceptible to the action of roentgen rays.

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RADIATION THERAPY OF KELOID AND KELOIDAL SCARS*

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KELOID in the beginning is a connective tissue overgrowth in the corium but later the growth is largely composed of broad bundles of dense connective tissue fibers with intervening spindle-shaped cellular elements.

True keloid and hypertrophic scars are considered by some pathologists as separate entities but many others consider them different manifestations of the same disease. In true keloid the skin glands and hair are supposed to be retained but not in keloidal scars. So-called true keloid is rare while keloidal scars are common. The latter, due to the marked scarring, contractures of the skin, pain, limitation of movement in the area involved, and the deformities, deserve careful consideration of the medical profession.

The overgrowths of fibrous tissues may be single or multiple and involve the skin over the front of the chest more frequently than elsewhere, but may involve any part of the body surface. Keloidal scars, on account of the exposed surfaces, usually involve the face, neck and hands. Both usually recur after surgical removal and react practically the same to various forms of therapy.

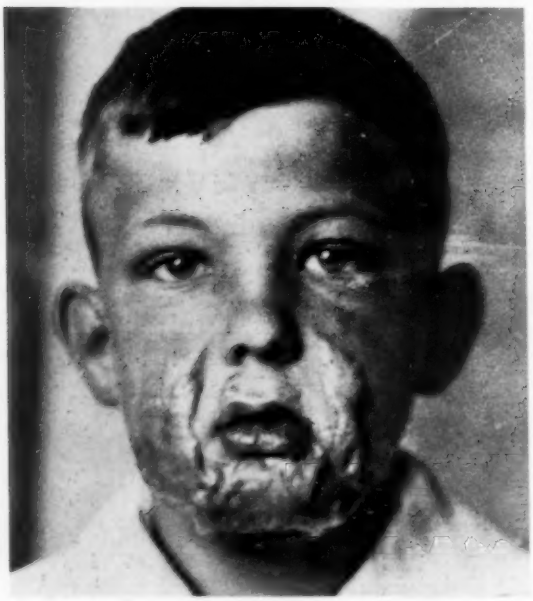

FIG. 1. Case 1. July 1, 1931. A severe keloidal scar caused by a burn received February 19, 1931, while investigating a gasoline tank with a lighted match. Four weeks later he returned to school, the skin having entirely healed. The latter part of March, keloidal formations were first noticed. He was first seen by us July 1, 1931. He received about 250 r unfiltered roentgen rays, 85 kv., every six weeks for one year. There was marked involvement of the lower lip as well as of the skin of the face. The face was so stiff this boy actually could not smile or laugh.

FIG. 2. Case 1. February, 1933. An excellent result has been obtained but an even better result is possible where cases are seen as soon as keloid formation begins.

In the treatment of this disease numerous methods have been employed. The pepsin hydrochloric acid digestant of Ahlswede, the formalin injection of Smyth, the oil of creosote injection of Lesieur, and surgery, except where it is to be followed by irradiation, have been almost entirely re-

* Read before the Richmond Academy of Medicine, May 11, 1933.

Fig. 3. Case 11. October 15, 1930. In April, 1930, this patient received a severe burn over the face, neck, chest and hands from a short circuit flash on an 11,000 volt line. The actual wires were about 3 feet from his face. He left the hospital on July 8 with contractures around the left eye, mouth, and neck, and the keloidal scars. He was first seen on October 15, 1930.

placed by radium and the roentgen ray in the treatment of this condition.

Taft, Daland, Wickham and Degrais, Simpson, and others, prefer radium as a therapeutic agent.

Grier, Pfahler, Knox, MacKee, Pancoast, Pirie, Kilbane, and others, prefer the roentgen ray. Pfahler believes that where it is possible to approximate the skin surface afterwards without too much tension the keloid itself should be removed and pre- and postoperative roentgen rays applied. Grier and Bowen believe that unfiltered roentgen rays are superior in the treatment of keloid, while Pancoast, Kilbane, Gerber, and others, prefer filtered rays. Kilbane and Grier use 80 to 90 per cent of an erythema dose per treatment; they recommend treatments every six to eight weeks and that a 90 per cent dosage not be exceeded. Sherman gives about the same percentage dose filtered through 1 mm. aluminum and advises that this dosage be divided so as to give weekly treatments. Kilbane reports excellent results in 30 of 53 cases, good results in 11, improvement in 3, poor results in 6. He found filtered rays to be preferable to unfiltered radiation as a standard treatment, and had fewer undesirable sequelae when filtered rays were used. He gave just below a skin unit dose every four or five weeks, using 1 mm. aluminum filter, and found repeated small doses better than a single large dose except in early small keloids. He concludes that probably all keloids can be destroyed by the roentgen ray if treated sufficiently and properly.

Daland, in an equally large series, reports excellent results with radium. In old keloids he uses beta radiation in addition to gamma, destroys the pigment layer of the skin and produces an ulceration. He advises 1 mm. silver filtration in growths

Fig. 4. Case 11. Same case showing large keloids on both hands. The scars were painful, very thick and hard. There was definite limitation of movement in the wrists.

Fig. 5. Case 11. October 19, 1932. Photograph taken after he had received from 150–250 r unfiltered roentgen rays every six to eight weeks for fifteen months. When this patient was first seen the mouth was pulled toward the left and he was unable to close his left eye. At the present time the skin of the neck shows slight wrinkling but there are no contractures and he can close the left eye without difficulty.

of recent origin, in children and in individuals of dark complexion, and advises unfiltered tubes in all other keloids. He carries the treatment to the point of ulceration. His results are certainly excellent but we believe they would be just as good with smaller doses and that there would be fewer sequelae.

Sheehan reports good results with the use of radium emanation tubes implanted in the incision following surgical removal of the growth. Depigmentation of the skin in negroes and the possibility of infection are unavoidable in this method of therapy. His explanation that radiation within the tissues helps lymph flow while if applied from the surface impedes the lymph is not borne out by our experience in such cases. New reports good results following the use of surgical diathermy and advises the use of radium to complete the smoothing out of the scar.

Our experience has been that very thick, more or less localized, keloids should be removed surgically and postoperative irradiation given. In the large majority of cases seen, however, this method of treatment is impractical and is frequently impossible on account of the very large areas of the body surface involved.

In small keloids or keloidal scars radium or the roentgen ray should be used and will in a large majority of all cases give excellent results. Pain is relieved after the first one or two treatments and the tumors melt rather rapidly. In extensive lesions at least a year is required for the best results. This must be explained to patients if their full cooperation is to be expected.

In our experience radium and roentgen rays are considered equally efficacious. In small lesions, especially in children, radium is preferable, but in the larger lesions roentgen radiation is in many ways superior to radium. It requires much less time to administer the treatment, the effect is the same, the dosage (and this is absolutely essential) can be more easily controlled, there is less danger of overlapping areas previously treated and, finally, where large areas are involved it is much less expensive.

Just as in the case of angiomata in infants, the one most important factor in the care of keloids is that the disease should be treated in its early stages.

Fig. 6. Case 11. The wrists and hands are now practically normal. The keloids have entirely disappeared.

Fig. 7. Case III. August 6, 1931. This patient was severely burned by the explosion of a gasoline stove March 10, 1931. She was first seen on September 4, 1931. The keloidal scars were first noticed in June or July. This demonstrates how rapidly keloid and contractures occur in some cases.

Rarely does the radiotherapist see these cases until a year or more after the lesions have appeared. During this time the opportunity for perfect results has passed. The terrific contractures, deformities and enormous growths do not occur in a few days but require weeks, months, or years for consummation. The younger the growth, the more radiosensitive the tissue and the smaller and fewer number of treatments required. A radiosensitive small lesion today may become a large, very radioresistant tumor six months or a year from now. When the medical profession realizes this fact and has every keloid or keloidal scar treated in its incipiency, then and only then can almost perfect results be obtained.

In early keloid or keloidal scars we have not found it necessary to give more than about 200-250 r unfiltered rays every five to six weeks. In a few instances we have given this in divided doses with equally good results. These small doses have caused the disappearance of early keloid in negroes without depigmentation of the skin. In older, extensive keloidal scars with small and large lesions widely scattered, each case should be individualized and a combination of unfiltered and filtered rays given. Even in these cases more than 60 per cent of an erythema dose has rarely been necessary. As emphasized by Grier, the size of the area treated must always be borne in mind if overdosage is to be prevented.

In very large keloids the most accurate possible dosage and spacing of the treat-

Fig. 8. Case III. October 20, 1932. It was first thought that the extreme contractures of the skin of the neck would require surgery but roentgen irradiation plus massage has almost entirely relieved these contractures. The treatments were spaced from six to eight weeks and about 200 r unfiltered rays given.

ments are essential if we are to avoid the unhappy after-effects of irradiation which are sometimes seen. In addition to the usual factors, milliamperage, spark gap, time, filter and distance, either very careful ionization measurements or the actual erythema time for the amount of skin area to be treated for the particular tube to be used, is necessary in the treatment of widespread early keloidal scars. Though it is generally known that variations in the size of the area treated may vary the erythema dose several hundred per cent and that when using unfiltered low voltage rays the output from a new tube may be almost 100 per cent more than that from an old tube with heavy tungsten deposits, these points have not been sufficiently emphasized in the treatment of keloid when large areas of the body surface are involved.

Telangiectasia and marked wrinkling of the skin will certainly follow overdosage or too frequent treatments. Haphazard dosage may and sometimes does result in chronic tissue damage which may require surgery. Davis has recently reported such a case.

Where the disease is seen in its incipiency only a few treatments are necessary. In the involution of keloid which occasionally occurs with no treatment, dilated capillaries, wrinkling of the skin, etc., have been noted by MacKee and others so it is not always possible to say that this sequel is due to the treatment.

Many marked skin contractures may be overcome entirely by the softening and disappearance of keloid tissue followed by daily massage with cocoa butter or other suitable skin lubricant. This is especially important where there are contractures of the skin of the neck and the skin around the mouth and the eyes.

Where a skin contracture shows a rather broad (several millimeters in diameter) white line of dense fibrous tissue, this should be cut, or partially or completely removed surgically, since it is impossible by any form of irradiation or massage to soften or completely destroy this tissue and relieve the contracture.

CONCLUSIONS

1. Very thick, more or less localized, old keloids should be removed surgically and postoperative irradiation given.

2. Radium and roentgen radiation are equally efficacious in the treatment of this condition but the large area of the body surface usually involved makes the roentgen ray the method of choice in the majority of cases seen.

3. Excellent results have been obtained with 250-300 r unfiltered rays, 80-90 kv. every four to six weeks. The large doses in general use have not been necessary.

4. The most important factor in the treatment of keloid is the institution of proper irradiation in the early stages of the disease while the cells composing the growth are very radiosensitive.

5. Where there are unsightly deformities, irradiation will usually relieve the contractures without surgery, but where there are broad white bands of dense fibrous tissue in addition to the scars, these bands should be removed surgically.

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EARLY HISTORY OF ELECTRON EMISSION

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THE EARLIEST observations that heated bodies lose electrical charges more rapidly than cold bodies date back to the middle of the nineteenth century. The first observations were contradictory but from 1882–1889 on, Elster and Geitel found conclusively that when metal wires are heated to higher temperatures, they send off negative electricity to a much larger extent than positive charges. All these experiments were made in air.

Then Edison, while working with incandescent lamps, found, as the first, that in a vacuum, a hot filament sends a negative charge over to a cold electrode, but the reverse did not take place to the same extent. Following this, Fleming found a practical application of this principle and devised the Fleming valve to rectify alternating currents and to change them into unidirectional currents.

Progress in these developments was hampered by the fact that the metals of which wires could then be drawn could not be heated high enough to give a sufficiently large current for practical purposes, and hence many contradictory results were published and a variety of conclusions were proposed. However, Wehnelt found a way of increasing the electron emission from metals by placing a small spot of alkali metal oxide upon a platinum foil and heating the latter to a dull, dark red temperature.

In January 15, 1904, he filed a patent for the first practical device embodying a high degree of vacuum with an electron-emitting heated cathode and a cold anode. This device was commercially manufactured and placed on the market by Emil Gundelach in Gehlberg, Thuringen, in 1909 and such valve tubes are still being marketed and sold at the present time.[1]

The Fleming valve, on the other hand, with a heated cathode of the metals then known or of carbon, did not become a practical success until a metal was found that could be heated to a higher temperature. Such a metal is tungsten, and from then on the experimental data found and published became more reliable and consistent, and Richardson speculated on a theory to explain the process or mechanism by means of which electrons are emitted from hot wires. To test his theory, he substituted into the equation that he had derived, the experimental data of a number of experimenters,[2] and therewith he proved conclusively the correctness of his theory. Thus from about 1901 on, the theory of Richardson has received experimental support and no important contradictory criticism.

According to this theory and in agreement with the experimental support it has received, a metal heated to a sufficiently high temperature emits electrons and the number of electrons so emitted depends to a small extent on the metal but principally on the temperature of the metal. Therefore, no matter how high the negative voltage may be that can be applied to the heated cathode, the number of electrons liberated from it is not changed, hence giving rise to what is known as saturation conditions. Stated briefly, the theory or equation of Richardson embodies and contains all the knowledge and data known until this day, upon which the operation of modern hot cathode devices is based.[3]

THE WEHNELT SCHOOL

As stated above, Professor Wehnelt, then of Erlangen, was the first to devise a prac-

[1] See Gundelach catalogues, for instance, the 1909 and 1928 editions. Wehnelt, A. Ein elektrisches Ventrilrohr. *Phys.-Med. Soz., Erlangen*, 1905, *37*, 264.

[2] Richardson, O. W. Emission of electricity from hot bodies. 1916, 81–82.

[3] Coolidge, W. D. A powerful roentgen ray tube with pure electron discharge. *Phys. Rev.*, 1913, *2*, 409–430.

tical thermoelectronic discharge device. He therefore was the first to find a way to obtain through his valve tube a discharge of sufficient magnitude to be of practical importance by finding a method of augmenting or increasing the otherwise insufficient discharge from hot electrodes. This method consists of decreasing the amount of work required to release electrons from a moderately heated metal by placing a spot of alkali oxide upon the metal. The nature of this phenomenon and of thermoelectronic emission was studied by him and his students first in Erlangen and after 1908 in the Physikalisches Institut, Berlin.

One of Wehnelt's students, Fritz Deininger, tested experimentally Wehnelt's ideas with regard to electronic emission from hot metals and from the oxide coated metals.[4] Wehnelt had held that, inasmuch as the emission of electrons from oxide cathodes obeys the Richardson equation, the electrons emitted from an oxide cathode came in reality from the metal, and that the oxide simply facilitates their release. Deininger verified this with Pt, carbon, Ta and Ni. He says in his conclusion:

> Platinum, carbon, tantalum and nickel, with and without covering of calcium oxide, emit negative ions. The relation between current and voltage has in these cases the same character. Always there were found decided saturation currents. The smallest voltage, therefore, required is between 20 and 25 volts. The Richardson equation for the relations between wire temperature and saturation current is verified in all cases.
>
> Glowing Pt, carbon, Ta and Ni wires not covered with CaO differ considerably concerning the number of negative ions sent out by them; i.e., the magnitude of the saturation current. Similarly n, i.e., the number of negative ions contained in 1 ccm metal, also ϕ, i.e., the work to be furnished to release an ion from the metal, a value that is characteristic for the metal.
>
> Glowing Pt, carbon, Ta and Ni wires covered with CaO show no difference in regard to the number of emitted negative ions. The values of n and ϕ are in the four cases the same.
>
> The number of negative ions sent out, i.e., the saturation current is for one and the same metal much larger with CaO covering than without it, etc.

Deininger, therefore, verified experimentally Wehnelt's idea and understanding of the thermoelectronic emission from hot metal wires and also corroborated his understanding of the function of the alkali oxides in respect to how they affect the electronic emission from moderately heated metal surfaces. It is particularly noteworthy that Wehnelt had made an invention over the prior art of that time in that he found a way of increasing electronic emission in general which at that time was insufficient for practical purposes because of the low melting point and the low emissive power of the metals then known.

Another student of Wehnelt's institute investigated experimentally the effects of various gas pressures upon the formation of positive ions and their effects upon the saturation from electron-emitting hot cathodes to cold anodes. Von Baeyer[5] concluded from his experiments with oxide, as well as with platinum cathodes, as follows:

> If the degree of vacuum was made as high as possible through the application of carbon cooled in liquid air, then it was easily attained that ionization, at not too high velocity, was no longer measurable with the described methods.

These expressions therefore indicate that the conditions of pure electronic discharges as depending on the degree of vacuum were then already correctly understood.

Regarding saturation, a conclusion of von Baeyer is as follows:

> This is the reason why real saturation curves are only then obtained, if lateral stray losses are avoided. Thus measurements on glowing wires could be carried out only when the stray losses are relatively small.

Therefore, not only did von Baeyer disclose clearly that saturation depends on in-

[4] Deininger, F. Ueber den Anstritt negativer Ionen aus einigen glühenden Metallen und aus glühendem Calziumoxyd. *Ber. d. deutsch ph. Gesell. V*, 1907, 674.

[5] von Baeyer, O. Ueber langsame Kathodenstrahlen. *Verh. d. deutsch. ph. Gesell. VI*, 1908, 96.

tercepting of all electrons emitted from the cathode, but he also showed how this is done experimentally and how with a cylinder of metal,[6] the direction of the electrons can be controlled. Saturation, according to von Baeyer, depends upon the absence of ionization and the avoidance of electron losses by stray radiation.

A still further step forward in the experimental development of hot cathodes was made by the Wehnelt school during a controversy between Wehnelt and Trowbridge. It was Trowbridge's contention that roentgen rays are generated only at high voltage, and it became Wehnelt's aim to show that roentgen rays can be produced with less than 100,000 volts, as claimed by Trowbridge. He constructed a roentgen tube with a hot cathode, which he described in 1905.[7] Dember[8] also for the same reason attempted to generate roentgen rays at very low voltage, and both concluded that roentgen rays are produced whenever an electron traveling at a velocity different from zero impinges upon solid structures.

Thus Gundelach[9] and Wehnelt[10] say:

> The discharge potential when the cold electrode is the cathode, according to the construction and degree of evacuation of the tube is many thousands of volts, and if the tube is very highly evacuated, there is a potential drop at the cathode, when it is the cold electrode, of many thousand volts.

A review of all Wehnelt's publications clearly brings out the fact that he sought to enlarge the general basic knowledge on the subject of electronic emission from hot bodies and that he taught all that he knew to his students and to the world at large in his publications. Thus in 1904[11] he compiled in forty-three pages the fundamental and basic knowledge that he had accumulated without making reference to one single practical application. Only the basic principles were disclosed to enable anyone to apply them for the carrying out of practical problems. Wehnelt is a teacher of fundamental principles most of which he discovered and that fact is again shown in that, to his student, Westphal, he suggested or described the method of how the electronic stream emitted from a hot cathode can be focused or directed upon any desired spot or area on the anode by means of electrostatic shields.[12]

Finally, however, in a popular journal, Wehnelt[13] wrote a popular article, "Über eine neue Methode zur Erzeugung von Kathoden, Röntgenstrahlen und anderen Lichterscheinungen in Geisslerschen Röhren." In this article, Wehnelt gives in detail his view of the electronic theory. In it he also describes the condition of saturation and the principle of electrostatic and electromagnetic deflection of the cathode-ray beam. Then he describes and illustrates a Braun tube with an oxide cathode, the method of generating roentgen rays, i.e., how he did it and how it could be done, and finally he describes the valve tube which, with several thousand volts, is capable of passing about 1/2 ampere of pulsating direct current.

In this article, Wehnelt had disclosed all that he had done in the way of practically applying his discovery and he left with the reader many suggestions as to how the fundamental principles disclosed could be further developed and applied. He there showed the world a new art, saying:

> These are the fundamental facts. That much have I done with them myself. Now much more can still be done with them to develop this art still further to greater practical usefulness.

[6] Loc. cit., see Figure 6.

[7] Wehnelt, A., and Trenkel, W. Die Erzeugung sehr weicher Röntgenstrahlen. *Sitzungsber. d. Phys.-Med. Soz., Erlangen*, 1905, *37*, 312.

[8] Dember, H. Ueber eine Methode zur Erzeugung sehr weicher Röntgenstrahlen im äussersten Vacuum. *Verh. d. deutsch., ph. Gesell. XIII*, 1911, 601.

[9] Prospectus of Dec. 1905, No. 61.

[10] Wehnelt, A. Ein elektrisches Ventilrohr. *Ann. d. Phys.*, 1906, *19*, 138.

[11] Wehnelt, A. Ueber den Austritt negativer Ionen aus glühenden Metallverbindungen und damit zusammenhängenden Erscheinungen. *Ann. d. Phys.*, 1904, *14*, 425.

[12] Westphal, W. Potentialmessungen an glühenden Oxyd Kathoden. *Ber. d. deutsch. ph. Gesell.*, 1908, 401.

[13] Wehnelt, A. Ueber eine neue Methode zur Erzeugung von Kathoden, Röntgenstrahlen und anderen Lichterscheinungen in Geisslerschen Röhren. *natur*, 1911, 74–78.

THE QUESTION OF HIGH VACUA AND OF PURE ELECTRONIC DISCHARGES

In the years 1910 to 1912, the prevalent method of producing a high vacuum was to use a Gaede rotating pump and to trap all vapors from it in charcoal and liquid air. In view of this very early date in the vacuum technique and of the fact that the modern devices for measuring high vacua were not then available, it might be argued that the observed results are not those found in really high vacua. Nevertheless, the characteristics of the discharges from high cathodes found by Wehnelt and his students, also the correctness of Richardson's equation, were fully substantiated from about 1913 on by Langmuir and Coolidge.[14]

But aside from all this, Hupka,[15] when the mass of rapidly moving ions was to be measured, produced probably the highest degree of vacuum, employing all the then known methods as a check and in fact he controlled his methods of evacuation with the greatest possible care so that his end-results were all consistent among themselves. Then he was able to accelerate electrons with voltages of 90-100 kv. and he proved conclusively that positive ionization was absolutely absent and that his discharge was one of pure electrons. The proof of this lies in the fact that he obtained, for various velocities, values for the mass of electrons that are consistent with the mass of those obtained for electrons from radium.[16]

Again Ernst von Angerer, a student of Roentgen, in 1912,[17] used Wehnelt cathodes with 20,000 to 30,000 volts and he measured the air pressure with a Kundson manometer.

[14] Coolidge, W. D., loc. cit. 3.

[15] Hupka, E. Beitrag zur Kenntniss der trägen Masse bewegter Elektronen. *Ann. d. Phys.*, 1910, *31*, 169.

[16] Hupka's work and that of Bucherer, was of the greatest importance to settle and to decide a theoretical controversy. Lorentz had proposed a formula giving the mass of an electron at various velocities. Various proofs pro and contra Lorentz were brought forward. Hence, Hupka's work was attacked, but in the end Hupka was completely and definitely affirmed.

[17] von Angerer, E. Ueber den Druck von Kathodenstrahlen. *Ann. d. Phys.*, 1913, 41.

Dember[18] states, "For evacuating, a Gaede pump was used and then wood charcoal in liquid air. During the important experiments the pressure was smaller than 10^{-5} m/m Hg." He used, for generating roentgen rays, up to 9,500 volts and a roentgen tube with a photoelectronic cathode.

Later, when the Gaede molecular and the Gaede diffusion pumps became known, it became very much easier and a quick process to obtain the same degree of vacuum as before.[19]

DISCHARGE INDEPENDENT OF THE VOLTAGE

One of the first observations made in 1853 by Becquerel was that discharges from hot electrodes do not obey Ohm's law. It was soon recognized that a limiting value arose for the charge emitted at one given temperature, and Wehnelt gave it the name "Grenzstrom" or limit current. Eisemann[20] showed that Grenzstrom and saturation current are identical. Not only Wehnelt,[21] but practically every other investigator, recognized the saturation condition and applied it as a known phenomenon without anyone ever questioning it again. Von Baeyer[22] explained the conditions under which the saturation condition is clearly obtained and disclosed a sort of focusing device or a tube which prevents the escaping of electrons sideways so that they cannot miss the anode.

All of Richardson's work is based on the existence of a saturation condition and not on any other form of discharge. Hence a clear understanding of it is fundamental before Richardson's book "The Emission of Electricity from Hot Bodies" can be read. In fact, the derivation of his equation is based on the fact that, at a certain given cathode temperature, there is emitted a definite number of electrons and that no matter how much the voltage between the

[18] Dember, H. *Verh. d. deutsch. Phys. Soz.*, 1911, 603.

[19] Pressler, Gundelach, Bürger, etc.

[20] Eisemann, *Verh. d. deutsch. Phys. Soz. XII*, 1910, 725.

[21] *Natur*, p. 75, loc. cit.

[22] von Baeyer, O. *Verh. d. deutsch. Phys. Gesell.*, 1908, *10*, 96.

anode and the cathode is changed, the current is independent of the voltage.

FOCUSING OF CATHODE RAYS

The first reference to the possibility that cathode rays can be focused upon an anti-cathode in an x-ray tube are found in Roentgen's second paper.[23] Since then all ionic roentgen tubes have been constructed according to Roentgen's directions.

The next description of a focusing device of cathode rays from a hot filamentary cathode is from von Baeyer.[24] In figure 6, he shows and in the text he explains how a brass cylinder placed over the hot cathode prevents the escaping of electrons sideways, and by these means, a discharge, the magnitude of which does not depend on the voltage, is secured.

In connection with oxide cathodes, there is the suggestion of Wehnelt communicated by Westphal[25] in which the use and purpose of a focusing cylinder is completely described. Even the question is discussed of how the appropriate potential is applied to this cylinder and how it will have to be adjusted relative to the cathode in order to give a desired size or area of a circular focal spot.

Aside from these two disclosures of the general purpose and function of a focusing cylinder, there have been no others which have added anything to the general knowledge, except those for special forms or shapes of the focal area. In fact, nothing can be added to these disclosures as they contain all that is general and fundamental on the subject of electrostatic focusing.

DISAGREEMENTS WITH WEHNELT AND WITH RICHARDSON

While many experimenters fully agreed with the interpretations of Wehnelt and Richardson, there were also several who interpreted their results in a different way. Notable among these is Fredenhagen who felt inclined to attribute the emission of electrons to chemical changes in the oxide or to the releasing of gas incidental to an electrolytic decomposition of the oxide. While he himself disproved the latter point by his own further experimental work, he seemed to have persisted in holding that the oxide expends its electron-emitting power in giving off gas or in being decomposed. He based his reasoning upon the fact that in some of his experiments the oxide lost its electron-emitting power and in a rather irregular erratic manner, regained it.[26] Other experimenters, however, not using the same methods of preparing the electrodes as Fredenhagen did, found results contrary to Fredenhagen's but in accord with Wehnelt's and Richardson's. In particular, Horton[27] had not been able to obtain Fredenhagen's results or to support his interpretations.

Richardson, in his book, on pp. 89-99, disposes of this controversy quite completely in stating that further experiments of Germershausen[28] subsequently corroborated and supported Wehnelt and Richardson and gave definite reasons for the erroneous observations and interpretations of Fredenhagen.

Misquoted quite frequently are Wehnelt and Liebreich.[30] An interpretation as being in conflict with the accepted theory or view on electronic emission, however, cannot be taken from this paper. The authors tried to show that the oxides used do absorb and tenaciously retain for long periods of time all sorts of impurities and admixtures. But they also state that if prepared free from such impurities, then, as other authors agree, the discharge is absolutely regular and it does not deviate in any way from the expected and accepted characteristics. Wehnelt himself stated that a properly prepared oxide cathode may be slightly unsteady until all Ta impurities and admixtures have disappeared, but from then on,

[23] Röntgen, W. C. Ueber eine neue Art von Strahlen. *Sitzungsber. d. phys.-med. Gesell., Würzburg*, 1895, par. 20–21.

[24] von Baeyer, O., *Verh. d. deutsch. phys. Soz. IV*, 1908, 105.

[25] Westphal, W. *Verh. d. deutsch. phys. Gesell. X*, 1908, 405.

[26] Fredenhagen, K. Das Verhalten der Wehneltelektrode in verschiedenen Gasen. *Ber. d. Kgl. Sächs. Ges. d. Wiss. Leipzig*, 1913, *65*, 42, and *Phys. Zeit.*, 1914, *15*, 19.

[27] Horton. *Phil. Mag. XI*, 1906, 505.

[28] Germerhausen, *Phys. Zeit.*, 1915, *16*, 104.

[29] Arnold, H. D. *Phys. Rev. XVI*, 1920, 70.

[30] Wehnelt and Liebreich. *Phys. Zeit.*, 1914, *15*, 557.

the cathode performs regularly for long periods of time and until the Ca or Ba is all evaporated.

The mechanism of an oxide cathode is known to be similar to that of (for instance) a thoriated filament. But these explanations are in no way in conflict with the accepted theory of electronic emission as prepared by Richardson and as supported by Wehnelt and his school.

HOT CATHODE ROENTGEN TUBES

The first immediate application resulting in a practical roentgen tube was probably made by Lilienfeld and Rosenthal.[31] This tube was evacuated to a very high degree and its performance depended upon the liberation of electrons from a heated filament in a high vacuum cooperating with an auxiliary cold constricting cathode. The penetrative power of the rays produced with this tube was independent of the vacuum and it could be regulated by varying the degree of heating of the hot filament. In order to definitely control the number of electrons coming from the cathode, an additional voltage is required, which also controls to some extent the mechanism by means of which the electrons are released from the filament and cathode. The acceleration of the electrons produced is of course produced by a high voltage applied between this electron-emitting cathode and its cooperating anode.

Characteristic of this tube is the fact that it is capable of blocking impulses from alternating current in the wrong direction, and also of controlling the discharge current entirely by adjusting the number of electrons from the cathode by means of either the filament temperature or the accelerating voltage. This tube, therefore, required three different voltages—one for heating of the filament, one for the control of the number of electrons and one for their acceleration. This caused the tube to be rather complicated in a practical sense, for which reason it was effectively superseded by the simpler construction of Coolidge.

The Coolidge[32] hot cathode tube has a spiral shaped cathode which is heated from an externally controllable heating current. A cylinder is placed over this spiral, which determines the size of the focal spot upon the anode, and in this tube the discharge is also at saturation or independent of the voltage. The number of electrons coming from the cathode is more easily controlled and besides the accelerating potential, only one source of current is required for this cathode instead of two, as is necessary for the Lilienfeld cathode.

In the application of this principle, however, it was recognized as fundamental that the degree of vacuum should be high enough to avoid all irregularities in the performance of the tube. This implies, therefore, that a high degree of vacuum is essential to obtain a smooth tube performance. Ulrey succeeded with neon with pressures of about 10^{-3} mm. Hg not only to reduce the space charge limitation to current, but also to obtain a perfectly smooth and regular discharge characteristic. Through this, easier vacuum maintenance and desirable discharge characteristics are successfully secured.

In both the design and the construction of hot cathode valve tubes and roentgen tubes, there have been introduced a number of novel features, but the fundamental principles applied are those discovered by the early investigators.

SUMMARY

The physical aspect of developments in this field is as follows:

1. The phenomenon of electronic emissions by hot bodies is very old, but up to 1903 no great or useful quantities of energy could be operated with, which was due to the lack of metals that could be heated to a sufficiently high temperature for a sufficiently copious emission.

2. Wehnelt invented a method of increasing the electronic emission to a prac-

[31] Lilienfeld, J. E., and Rosenthal, W. J. Eine Röntgenröhre von beliebig und momentan einstellbarem, vom Vakuum unabhängigem Härtegrad. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1911–1912, *18*, 256–263.

[32] Coolidge, W. D., loc. cit. 3.

tical volume, and he and his students found that in a high vacuum the saturation condition existed and that focusing of the electron stream is possible.

3. Wehnelt developed the first practical valve tube and then applied his methods to construct a new Braun tube with a hot cathode and then he built a hot cathode roentgen-ray tube.

4. Richardson worked out a theory on electronic emission and found existing experimental data to support it.

5. Wehnelt still further advanced the art and suggested means and methods of concentrating a hot cathode discharge upon a predetermined focal area.

6. Tungsten, molybdenum and tantalum wires became available. They can be heated to a higher temperature and to a higher emission of electrons than all the metals then previously known. Also they have greater mechanical strength so that radio tubes, valve tubes, roentgen tubes, Lenard cathode-ray tubes, etc., became possible, which to be practical require emission of large discharges from heated cathodes.

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EDITORIAL

THE RELATION OF RADIATION TO GENETICS AND THE MUTATION THEORY OF CANCER

ONE of the disadvantages of specialization is that, interested in and surrounded by problems of limited scope, the specialist often is not aware of developments in other fields of science which may be more or less closely related to his own. Thus when, among the list of subjects to be discussed at the next International Congress of Radiology, medical radiologists read "Radiation Genetics," many asked what on earth this could mean. Among physicians, also, few indeed are even aware of the existence of the mutation theory of cancer, in spite of the fact that a growing body of evidence makes this theory extremely interesting. Moreover, if the evidence now available should be substantiated by further experiments, the significance of the mutation theory may well become such as to overshadow all other theories, because it would explain how chronic irritation, exposure to roentgen rays or radium under certain conditions and other factors operate as causes of cancer.* The relations of radiation to genetics, therefore, should interest every medical radiologist, because it may be only a matter of time before the relationship is fundamentally significant.

It was in 1815 that Lamarck enunciated the ideas that the development of a new organ in an animal results from a new requirement or need which, by continuing to make itself felt, gives rise to new movements caused or encouraged by the new requirement. The development of organs is proportional to the employment or activity of these organs. All that is acquired or changed in the organization of individuals is preserved by generation and transmitted to new individuals derived from those in which the changes previously occurred.

Fifty years later, Darwin expressed the idea that the evolution of species was a matter of natural selection and transmission of acquired characters which enabled certain species to survive in the struggle for existence, the well known "survival of the fittest."

When a cell divides by mitosis into two daughter cells, the chromatin of the nucleus of the parent cell also divides into a number of segments known as chromosomes; each chromosome divides longitudinally into two halves, and one-half of each chromosome goes to form the nucleus of each of the two daughter cells. Thus, the number of chromosomes in each daughter cell is the same as the original number of chromosomes in the parent cell. Moreover the number of chromosomes in each cell of a given species of animal or plant is fixed and constant. When the sexual or germinal cells undergo maturation, the nucleus loses one-half of its chromosomes, but the number characteristic for each species is restored when, as the result of fertilization, one-half of the chromosomes in the sperm cells are added to the half already present in the ovum. Thus, one-half of the chromosomes in the fertilized ovum are derived from the mother and one-half from the father. In order to account for the fact that, by this mechanism, all kinds of hereditary characters are transmitted, geneticists have come to assume that each chromosome is composed of a large number of minute particles, called "genes," each of which is responsible for

* Anyone interested in the mutation theory of cancer may find an excellent review in: Gricouroff, G. Le cancer peut-il etre considéré comme une mutation cellulaire? *Paris méd.*, 1932, *22*, 237–244.

the transmission of a particular character, such as color of hair, character of hair, color of eyes, and so forth. According to this conception the gene is the real unit of heredity. That this assumption is not the result of an over-active imagination is shown by the fact that knowledge of a given stock now enables geneticists to predict with a high degree of accuracy the characters of the descendants and also, by special breeding methods, to influence the combination of genes in such a way as to obtain any desired character among the descendants. The appearance and indefinite transmission, from generation to generation of a given species, of a new character which had not been present in the parents constitutes what is known as a mutation. Necessarily such a mutation implies a change in one or more of the genes in a chromosome. Since the genes are too small to be studied with a microscope, only by appropriate breeding methods can gene mutations be discovered. When the mutations affect entire chromosomes, modifications in their number, linking, and structure can be directly recognized since chromosomes are microscopically visible.

Among animals and plants, hereditable variations or mutations have long been known to occur spontaneously, but under natural conditions the frequency of such occurrences, which varies from one species to another, is quite small. Until recent years, numerous experimental attempts to induce or duplicate the known mutations of spontaneous origin had consistently failed. As late as 1911 attempts to induce mutations by means of roentgen rays or radium had been made without success. In the last few years, however, owing to increased knowledge of genetics and to improved methods of breeding, it has become possible to induce, and even to reverse, mutations. Much of this work, the import of which is far-reaching, has been carried on in this country by Mavor, Muller, Patterson, Hanson, Heys, Harris, Painter, Plough, Weinstein and others. An interesting feature of the problem is that one of the successful methods of inducing mutations has been exposure to roentgen rays or radium. Thus, Muller (1927) reported that he had been able to induce, in *Drosophila*, visible and lethal mutations by exposing the flies to roentgen rays. After so many years of failure, this announcement naturally created great interest among geneticists. In 1928, Muller also recorded success with variations in temperature. Muller's results were soon confirmed by Weinstein (in 1928 working with roentgen rays) and by Hanson and Stadler (working with radium), and during the next few years many workers in America and in Europe successfully applied the new methods to various species of plants and animals.

In a recent paper Hanson* reviews certain phases of the problem. Among the questions taken up in this review is whether natural, or spontaneous, mutations are due to natural radiations. Using flies (*Drosophila*) and an electroscope, Babcock and Collins, after having discovered in a tunnel in San Francisco a point where the natural radiation was twice as great as in their laboratory in Berkeley, tested the rate of incidence of sex-linked lethal mutations in both places. The lethal mutation rate in the San Francisco tunnel was found to be almost twice as great as that in the Berkeley laboratory. Likewise, Hanson and Heys carried out experiments on *Drosophila* in St. Louis, and also in an abandoned carnotite mine in East Paradox Valley, Colorado, where the atmosphere was strongly ionized. The difference in mutation rate between the laboratory in St. Louis and the Colorado mine location was found to be 2.09 times the probable error. These results seemed to bear out the possible influence of natural radiation, until Muller and Mott-Smith (1930) showed that the natural frequency of mutation is at least 1300 times as great as it would be if caused by natural radiation. The suggestion that cosmic rays might be a factor in the rate of gene mutations has also been entertained, but, owing to

* Hanson, F. B. Radiation genetics. *Physiol. Rev.*, 1933, *13*, 466.

practical difficulties, experiments to test this possibility have not yet been undertaken.

Another phase of the problem is whether variations in genetic elements induced by roentgen rays, radium, and other methods are always "progressive," or whether such mutations may be both "progressive" and "destructive." On the assumption that the changes induced by roentgen rays or radium are usually destructive in character, it seemed highly important to determine if mutations induced by exposure to such rays are always retrogressive. The investigations of Muller (1927), Weinstein (1928), Muller and Painter (1929), Painter and Muller (1929), Muller (1930) and many others appear to have demonstrated that mutations not only can be induced but that once induced, they can be reversed, and the modified feature, be it a change from the dominant normal bristles to forked bristles in *Drosophila*, continue to breed true. By similar methods it has also been possible to induce gene mutations, and numerical as well as structural derangements (breakage and translocations of parts) of chromosomes, in both somatic cells and germ cells. The rate of mutation has been found to be only slightly influenced by variations in temperature; exposure to roentgen rays after starvation has been shown to yield a lower mutation rate, and irradiation during anesthesia a higher mutation rate than in similarly starved or anesthetized control flies.

In flies exposed to roentgen rays or radium the frequency of mutation has been found to be proportional to the dose, regardless of whether this was given at a single exposure or in several fractional doses, provided the total period of exposure was equal. In connection with some genetic factors the frequency of mutation induced by irradiation was about 250 times that of the normal, whereas the frequency of an allelomorph was over 300 times the rate found in unirradiated flies. At the present time heat and radiation are known to increase the rate of mutation, the former about 100 per cent, and the latter about 15,000 per cent. It is probable that other, still unknown, agents may subsequently be found to increase the frequency of mutation. Just as different varieties of living cells are known to vary in sensitiveness to roentgen rays and radium, different species of plants and animals vary in their natural rate of mutation as well as in the rate of mutation induced by irradiation, but the reasons for such variation are not yet known. Some experiments seem to indicate that the number of chromosomes in the cells of different species may be a significant factor, but this question remains unanswered.

Bauer, and especially Boveri, appear to have been the first to entertain the possibility that cellular mutation might have an important bearing on the cancer problem. It has long been known that cancer can be induced by various chemical substances (tar, arsenic, aniline dyes, and so forth), by physical agents (light, ultraviolet rays, roentgen rays, radium, heat), by parasites, and by other factors which act as direct or indirect cellular irritants. All these factors cause destructive lesions, and the destroyed cells are repaired by proliferation of other cells. Moreover, since such proliferation takes place in an abnormal environment, these factors and conditions are precisely those which favor cellular mutation. It is not illogical to suppose that the same mechanism operates to cause spontaneous tumors as well as tumors induced by various artificial means. The occurrence in the nuclei of malignant cells of an abnormal number of chromosomes was first recorded by Hansemann in 1891, and since then many others, notably Levine, not only confirmed Hansemann's observations, but also found different varieties of abnormal mitoses in the cells of different tumors in man, and in the mouse, rat, and other animals.

According to Boveri (1914), the proliferation of cells is regulated by a mechanism arising from the interaction of neighboring cells, and this mechanism is within the

nuclei of the cells. Any disturbance of the chromosomes within the nucleus may destroy this regulatory mechanism, and abnormal proliferation of cells may result. This was not the armchair conception of a dreamer, but was the result of prolonged observation of the fecundation and segmentation of the eggs of echinoderm, in the course of which he had repeatedly noted abnormal masses of cellular material arising from cells that had failed to divide regularly. When he counted the number of mitoses in a culture of normal cells and in a culture of cells of carcinoma from a mouse, Fischer (1931) also found ten times more mitoses in the malignant culture, and he concluded that the growth of tumors is an abnormal manifestation of cellular regeneration. In a still more recent communication, Fischer-Wasels (1932 and 1933)* offers additional evidence to support the view that cellular mutation may be at the bottom of the cancer problem.

The fact that roentgen rays and radium can be successfully used to induce mutations in certain animals commonly employed for genetic experiments, and the probability that cellular mutation has something, if not much, to do with the incidence of malignant hyperplasia of cells, naturally leads one to consider the possibility that irradiation of normal tissues or of inflammatory lesions might give rise to cancer. That cancer does occasionally develop in normal tissues exposed to excessive doses of roentgen rays or radium has been known for a long time. One thing that is not so well known is that, as Lacassagne and Vinzent have recently demonstrated, excessive irradiation of benign or inflammatory lesions likewise can lead to the formation of malignant tumors. This is one of the capital reasons why, when irradiating normal tissues or inflammatory processes, it is so essential to avoid doses that may cause reactive inflammation.

A. U. Desjardins

* Fischer-Wasels, Bernhard. Experimentelle Grundlagen und Folgerungen der Regenerationstheorie der Geschwulstbildung. *Klin. Wchnschr.*, 1932, *11*, 1937; 1977. Erblichkeit und Geschwulst-Bildung. *Deutsche med. Wchnschr.*, 1933, *59*, 1489. Editorial. *J. Am. M. Ass.*, Jan. 20, 1934, *102*, 214.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.
Annual Meeting: Pittsburgh, Pa., Sept. 25–28, 1934.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual meeting: Cleveland, 1934.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio.
Annual meeting: Cleveland, Ohio, June 11–15, 1934.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N.Y.
Annual meeting: 1934, to be announced.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. W. B. Firor, 1100 N. Charles St., Baltimore.
Meets third Tuesday in each month from September to May.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY
Secretary, E. N. Liljedahl, Los Angeles, Calif.
Meets on the third Wednesday of each month at the California Hospital.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. F. B. Bogart, Medical Arts Bldg., Chattanooga, Tenn.
Annual meeting: San Antonio, Texas, November, 1934.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. G. W. Cramp, 921 President St., Brooklyn, N.Y.
Meets monthly on first Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N.Y.
Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. G. Willy, 1138 N. Leavitt.
Meets second Thursday of each month October to May inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. H. G. Reineke, Christian R. Holmes Hospital, Cincinnati, Ohio.
Meetings held monthly.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. Otto Glasser, Cleveland Clinic.
Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla.
Meetings held twice a year, May and November.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. W. Grote, 219 N. Main St., Bloomington, Ill.
Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring. Next meeting, Detroit, Mich., February, 1934.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.
Meets first Friday in October, December, February, and April. Place of meeting designated by the president.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. C. W. Schwartz, 33 E. 68th St., New York.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N.C.
Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. F. C. Rulison, Medical Arts Bldg., Syracuse, N.Y.
Three meetings a year—January, May, and November.

PACIFIC ROENTGEN CLUB
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif.
Meets annually, during meeting of California Medical Association

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. W. E. Reiley, Clearfield, Pa.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Karl Kornblum, Graduate Hospital.
Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N.Y.
Secretary, Dr. W. W. Fray, Strong Memorial Hospital.
Meets monthly on second Thursday from October to May, inclusive, at 7:45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary, Dr. W. K. Mueller, University Club Bldg.
Meets first week of each month. Time and place of meetings designated by president.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston.
Meets at time and place of South Carolina State Medical Association.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Texas Radiological Society
Secretary-Treasurer, Dr. J. H. Smith, Lubbock, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association. Next Meeting. San Antonio, May 7, 1934.

University of Michigan Department of Roentgenology Staff Meeting.
Secretary, Dr. C. B. Peirce, University Hospital, Ann Arbor, Mich.
Meets each Monday evening from September to June, at 7 P. M. at University Hospital.

University of Wisconsin Roentgen Club
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis.
Meets monthly on last Thursday, October to April, Service Memorial Institute, at 4:30 P.M.

Virginia Roentgen Ray Club
Secretary, Dr. V. W. Archer, University Hospital, University, Va.
Meets annually in October.

Cuba

Sociedad Cubana de Radiologia y Fisioterapia
Secretary, Dr. Luis Fariñas, Animas 110, Havana, Cuba.
Meets monthly in Havana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

Electro-Therapeutic Section of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

Section on Radiology, Canadian Medical Association
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

Indian Radiological Association
Secretary, Sd. Subodh Mitra, 148 Russa Rd., Calcutta.
Meets annually in January, and at such places and times as the Council may appoint.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain, (Belgian).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summer time.

Société de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

Société Française d'Electrothérapie et de Radiologie Médicale
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German University, Prague, II/52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April in different German cities, at least once in five years in Berlin. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent Secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

Dutch Society of Electrology and Roentgenology
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

Societa Italiana Radiologia Medica
Secretary, Professor M. Ponzio, University of Turin, Turin.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Maracine 30, Bucharest, Rumania.
Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR, in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

Polish Society of Radiology
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw.
Meets annually.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summer time.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summer time.

Society of Medical Radiology of Sweden
Meets in Stockholm.

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. H. Scheuermann, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Society of Roentgenology
Meets first Tuesday each month, October to July.

Orient

Japan X-Ray Association
c/o Orthopedic Surgery, Tokyo Imperial University
Meets annually in April.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike, Kyoto, Japan.
Meets bi-monthly on third Sunday.

AMERICAN BOARD OF RADIOLOGY

The need for improved standards in the various medical specialties has become increasingly apparent during the past twenty years. Specialism is necessary in medical progress, but evils have attended its development in this country. The worst of these is the assumption of the title "specialist" by men with inadequate training and experience. Methods of licensure for the practice of medicine in this country are so complicated, being under forty-nine different jurisdictions, that it has never seemed feasible nor advisable to attempt to bring specialists under legal control beyond that required by their license to practice medicine. Several of the specialties have attempted to bring about a measure of control and improvement within their own special fields by establishing examining boards to certify to the qualifications of specialists in their own branch of medicine. Particular credit is due to the pioneer board in ophthalmology which was organized in 1916, and to its Secretary, Dr. William H. Wilder, for assistance in the formation of succeeding boards in other specialties. After several years' successful operation of the original Board of Ophthalmology, boards were formed successively for otolaryngology, obstetrics and gynecology, dermatology and syphilology and for pediatrics. Radiologists wish to record their appreciation for the help and inspiration that they have received from the secretaries of all of the established boards.

The desirability of instituting a board for radiology had been discussed for several years among radiologists, and the matter was brought to a head at the meetings of the American Medical Association and the American College of Radiology held in New Orleans in 1932. At that time committees were appointed by the College of Radiology and the Section on Radiology of the American Medical Association to investigate as to the advisability of forming such a board. At the suggestion of the Council on Medical Education and Licensure of the American Medical Association this matter was brought to the attention of the American Roentgen Ray Society, the Radiological Society of North America and the American Radium Society at their annual meetings, and each of these societies likewise appointed a committee to investigate the advisability of forming such a board.

The committees representing these five radiologic organizations met on June 11, 1933, in Milwaukee during the meeting of the American Medical Association, effected a preliminary organization and adopted the following recommendations to be presented to each of the five associations represented:

1. That it is the sense of this joint committee that a national examining board for radiologists be formed.

2. That it be recommended to each of the five societies here represented that three members be appointed by each of the societies to constitute a national examining board for Radiology.

3. That the purpose of the Board shall be the examination and certification of radiologists.

4. That the Board thus formed be authorized to effect its own organization, elect officers, adopt rules of procedure and proceed to the examination and certification of candidates.

The above recommendations were approved by each of the societies, namely, the American College of Radiology, the American Roentgen Ray Society, the American Radium Society, the Radiological Society of North America and the Section on Radiology of the American Medical Association. Three members were appointed from each of the societies to form the Board.

The organization meeting of the Board was held at the Palmer House in Chicago on September 28, 1933, during the first American Congress of Radiology, and H. K. Pancoast was elected president of the Board and B. R. Kirklin secretary-treasurer. A committee consisting of W. F. Manges, A. C. Christie and John W. Pierson was appointed to draw up by-laws and secure the incorporation of the Board.

The Board met again in Washington,

D.C., on January 27 and 28, 1934, at which time by-laws and articles of incorporation were adopted. The following permanent officers were elected: H. K. Pancoast, president, A. C. Christie, vice-president, and B. R. Kirklin, secretary-treasurer.

The purposes of the Board according to the by-laws are as follows:

(*a*) To elevate the standards and advance the cause of Radiology by encouraging its study and improving its practice.

(*b*) To test the qualifications of those who profess to be specialists in Radiology by arranging and conducting examinations of voluntary applicants for the certificate of the Board, and to issue certificates to those found qualified therefor.

(*c*) To prepare and maintain a registry of holders of the certificate of the Board.

(*d*) To serve the public, physicians, hospitals and medical schools by furnishing lists of those who have received the certificate of the Board and thus to assist in protecting the public against irresponsible and unqualified practitioners who profess to be specialists in Radiology.

The rules of the Board require that applications for certificate be made upon a prescribed form to be secured from the Secretary.

Each applicant must establish to the satisfaction of the Board that he is of high ethical standing, that he is a graduate of a medical school approved by the Board, that he is a member of at least one of the societies which appoint members of the Board, that he has had satisfactory experience in the practice of Radiology and that he is a physician duly licensed to practice medicine.

The by-laws of the Board provide that "each applicant for the certificate of the Board shall be examined in such manner and under such rules as the Board may prescribe, due weight being given in each individual case to professional attainments, years of training and practice, teaching and other positions held." It will be understood from this that the Board intends to fix the extent and the scope of the examination in each individual case. The successive steps in a *complete* examination are as follows:

1. Submission to the Secretary of the prescribed application form properly filled out.

2. Submission to the Secretary of reprints or original thesis.

3. Personal appearance before the Board for oral and practical examination.

The candidate will be informed after each successive step what is further required of him.

The experience of the Boards already functioning has been very satisfactory, and it is the general opinion that they have served to improve conditions in each specialty represented. Based upon their experience the following advantages may be expected from the functioning of The American Board of Radiology:

1. Certification by the Board furnishes a criterion to both lay and professional groups for judging a radiologist's qualifications.

2. Hospitals and other organizations will gradually establish rules limiting service on their staffs to those certified by the Board.

3. It will gradually tend to limit specialization to those who are qualified to practice this specialty.

4. National and other special societies will eventually limit their membership to those who hold the Board's certificate.

5. The laity will gradually become informed of the importance of choosing specialists who are certified by the Board.

6. Physicians in choosing consultants and in referring patients will gradually turn to those who are certified and thus help to eliminate those who are not qualified to practice Radiology.

The first examination will be held in Cleveland, Ohio, immediately preceding the meeting of the American Medical Association in June.

All radiologists interested should write to Dr. B. R. Kirklin, Secretary, Mayo Clinic, Rochester, Minnesota.

B. R. Kirklin

FOURTH INTERNATIONAL CONGRESS OF RADIOLOGY

ZURICH, JULY 24–31, 1934

SECOND COMMUNICATION*

More than 8000 invitations have been sent to the members of the radiological societies participating in the Congress. A satisfactory number have already signified their intention to attend. The President of the Swiss Confederation will open the Congress on July 25, 1934. At this meeting Professor Gösta Forssell will report on the organization of the cancer campaigns in general. Other speakers will report upon the measures in their own countries. The majority of the speakers invited by the Committee have accepted.

The program of the General Meetings is as follows: "X-Ray Diagnosis of Bone Tumors" by Dr. Kienböck, Vienna; "Pulmonary Tuberculosis as Seen Roentgenologically" by Dr. Herrnheiser, Prague; "Radiation Treatment of Carcinoma of the Uterus" by Dr. Lacassagne, Paris; "Radiation Treatment of Malignant Tumors of the Mouth and Pharynx" by Dr. Perussia, Milan; "Radiation Genetics" by Dr. Muller, Austin, Texas; "Mitogenetic Radiation" by Dr. Gurwitsch, Moscow; "Structure Analysis" by Dr. Bragg, Manchester; "Identical Physical Measurement of the Dose in X-Ray and Radium Treatment" by Dr. Holthusen, Hamburg; "Hard Gamma Rays, Cosmic Radiation, Earth Radiation" by Dr. Sievert, Stockholm; "Short Wave Therapy" by Dr. Carelli, Buenos Aires.

The social events connected with the Congress will follow the usual lines. In addition to the official reception and the closing banquet a festival of traditional costumes and customs of the Swiss Cantons will be arranged by a special committee.

W. E. WALTHER
General Secretary
Gloriastrasse 14, Zurich

* See the October, 1933, issue of the Journal for the First Communication.

RULES AND REGULATIONS FOR THE INTERNATIONAL RADIOLOGICAL CONGRESSES

1. The International Radiological Congress has for its object the development and advancement of medical radiology, by giving radiologists in different countries an opportunity for personally submitting their experiences, exchange and discuss their ideas, and form personal bonds with their colleagues.

2. The Congress shall be held every third year.

3. Members of the Congress may be:
   1. Members of Radiological Societies in all countries.
   2. Persons proposed by Radiological Societies.

4. The meetings of the Congress shall be reserved for matters dealing with the following branches: Röntgen diagnosis, radio-biology, radio-therapy (= Röntgen-therapy, Curie-therapy, helio-therapy), medical electrology, radiophysics and concomitant branches.

5. An International Committee for radiology shall consist of delegates elected by the Radiological Societies of the various countries, and shall form the Supreme Council for the International Radiological Congresses.

6. Every country which has one or more radiological societies shall be entitled to elect not more than 5 delegates to the International Radiological Committee. The delegates from each country shall elect a Chairman from amongst themselves.

7. Delegates to the International Committee shall be appointed not later than one year prior to each Congress. They shall be appointed jointly by the respective country's principal radiological society or societies.

8. The International Radiological Committee shall be elected for a period of three years and shall carry on its function until such time as the election of a fresh committee has taken place at the next Congress.

9. The President of the Congress shall be Chairman of the International Committee.

10. The International Radiological Committee shall meet on the day before every Congress and in the course of the Congress as often as may be deemed necessary or suitable.

11. The International Radiological Committee shall be entitled:

1. To fix the place and date for the next Congress.
2. On the suggestion of the delegates from the country, in which the next Congress is to be held, to elect the President for the next Congress,
3. To pass resolutions concerning the general rules and regulations for the organization and work of the International Radiological Congress.

12. Each country shall be entitled to one vote which shall be exercised by the Chairman of the National Committee of delegates for that Country.

13. The chairman of the delegates from each country shall be entitled to submit proposals relating to the work of the International Radiological Committee and Congress. Such proposals shall be submitted to the Chairman of the International Committee not later than 3 months prior to the next Congress.

14. The delegates from each country to the International Radiological Committee shall constitute a national committee, whose duty it shall be, within that country, to further the interests of the International Radiological Congress.

15. The International Radiological Committee shall elect from amongst its members an Executive Committee consisting of five persons of which Executive Committee previous Presidents shall also be members. This Executive Committee shall have to prepare and deal with such matters as may be submitted to the International Radiological Committee.

16. The President of the Congress shall be Chairman of the aforesaid Executive Committee and shall himself appoint his secretary.

17. The Executive Committee shall meet immediately prior to each meeting of the International Radiological Committee, and otherwise when the Chairman may so decide.

18. The President may obtain the opinion of the members of the Executive Committee by correspondence and act upon the majority of the votes. The President shall have a deciding vote in case of a tie. For urgent matters the Executive Committee shall form a quorum when three members are present and their action shall be acceptable when the vote is unanimous.

19. For defraying the expenses of the International Radiological Committee each International Radiological Congress, from the membership fees received, shall place a sum of $200 at the disposal of the newly elected President. An account for this amount shall be submitted together with any possible balance, to the Executive Committee then in function not later than three months after each Congress.

20. The President elected for the next Congress shall, in consultation with the delegates from the country where the Congress is to be held, elect the board of management and all the officials of the Congress.

21. The National board of management of the Congress shall be entirely responsible for all the Congress arrangements, financial and otherwise.

22. Any suggested alteration in these rules must be submitted through the Chairman of any group of delegates to the President for the time being. Any alteration in order to become effective must be approved by a two thirds majority of

1(1) the Executive Committee and

2(2) the International Committee.

23. *Badge and Chain of Office presented by the British Institute of Radiology.*—The President for the time being is in charge of and responsible for the badge and chain of office until the following Congress. He will at this Congress hand them over to the new President.

The following rules shall govern the course of the Meetings

1) Every member of the Congress shall be entitled to speak in his native tongue, but it is in the interests of the International Congress that lecturers and speakers shall use a language which is understood by the majority of the members of the Congress.

2) The printed documents of the Congress shall be published exclusively in English, French, or German.

3) Official proceedings of the Congress shall not be published.

4) Before the Congress there shall be published through the board of management of the International Congress summaries of lectures and addresses notified, and these shall be compiled in book form and forwarded to the members of the Congress not later than 6 weeks prior to the commencement of the Congress.

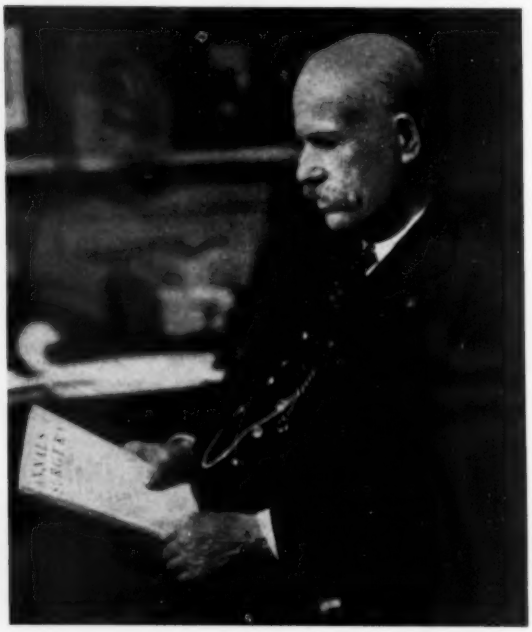
5) No address shall exceed a period of 15 minutes, and no contribution to the discussion, more than five minutes.

6) The Press shall not be officially admitted at the Congress; nevertheless, each member is

at liberty to supply private information to scientific journals.

ANNALS OF SURGERY CELEBRATES GOLDEN JUBILEE

The AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY wishes to extend its congratulations to the *Annals of Surgery* which is celebrating its Golden Jubilee, and especially to Dr. Lewis Stephen Pilcher, its Editor, who has the distinction of having served in that capacity since the beginning of the *Annals* in 1885.



LEWIS STEPHEN PILCHER

Dr. Pilcher entered the University of Michigan at the age of thirteen and took his bachelor's degree at the age of seventeen. The next year he added his master's degree and in the same year began the study of medicine. This was in 1863 when the Civil War was raging. The next year found him with enough medical knowledge to volunteer as a hospital steward and throw himself into the thick of service to the sick and wounded. That was the beginning of his medical experience—seventy years ago.

He returned to the University of Michigan and received his doctor's degree in 1866. Since that time he has been in turn a country practitioner, Assistant Surgeon in the United States Navy during which assignment he had much experience with people and practice and acquired first hand knowledge of yellow fever. He retired from the Navy in 1872 and entered private practice.

Dr. Pilcher originated the *Annals of Surgery* in 1885 and has continued as its Editor to the present day. That journal has always reflected its Editor's standards of quality. As the official organ of the American Surgical Association, the New York Surgical Society and the Philadelphia Academy of Surgery, it has profoundly influenced American surgery. For his devotion to such a cause, medicine in general owes a debt of gratitude to Dr. Pilcher.

MICHICAN ASSOCIATION OF ROENTGENOLOGISTS

The sixth meeting of the Michigan Association of Roentgenologists was held November 25, 1933, in Kalamazoo. The following were elected officers for the coming year: President, Dr. M. W. Clift, Flint; Vice-President, Dr. F. J. Hodges, Ann Arbor; Secretary-Treasurer, Dr. S. W. Donaldson, Ann Arbor.

The scientific program consisted of a symposium on "Pathological Lesions of the Spine" and the following speakers were heard: Dr. F. C. Kidner, Detroit—"Backache of Extrinsic Spinal Origin"; Dr. Harold Morris, Detroit—"Urological Disease as a Factor in Backache"; Dr. H. P. Doub, Detroit—"Spinal Anomalies Mistaken for Fracture"; Dr. Carl Badgley, Ann Arbor—"The Lumbosacral Joint"; Dr. E. R. Witwer, Detroit—"The Deferential Diagnosis of Deformities of the Vertebral Body"; Dr. E. W. Hall, Detroit—"Prognosis of Vertebral Body Fracture."

Detroit was selected for the next meeting which will be held in February, 1934.

NOTICE

Dr. E. L. Jenkinson, Treasurer of the American Roentgen Ray Society, wishes to call to the attention of members the fact that this year membership cards are not being forwarded upon payment of dues. The signed receipt is considered sufficient.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

Human Cancer: Etiological Factors; Precancerous Lesions; Growth; Spread; Symptoms; Diagnosis; Prognosis; Principles of Treatment. By Arthur Purdy Stout, M.D., Associate Professor of Surgery, College of Physicians and Surgeons, Columbia University; Attending Surgical Pathologist, Presbyterian Hospital, New York. Cloth. Price, $10.00. Pp. 1007, with 331 illustrations. Philadelphia: Lea and Febiger, 1932.

This ambitious volume covers, as the title indicates, a huge mass of material. The method of approach is unusual and quite practical in that each part of the body is dealt with separately, the various tumors, both benign and malignant, that may occur in each region being described so that they can be differentiated. To the physician who is not intimately familiar with the imposing array of new growths that now fill the textbooks on pathology, this volume should be a great boon since he can with its aid trace down quickly the known possibilities when he is confronted with an unusual tumor. It should be particularly valuable as a reference book in the tumor clinics that are being formed in the smaller institutions throughout the country.

Separate chapters deal with the oral cavity; dental apparatus; salivary glands; esophagus; stomach; liver and intrahepatic bile passages; gallbladder and extrahepatic ducts; pancreas and ampulla of Vater; intestine and rectum; appendix; peritoneum, omentum, mesentery and retroperitoneal tissues; mammary gland; uterus; vulva and vagina; urethra; tube and broad ligament; ovary; testis and epididymis; vas deferens, tunics of testis and cord; penis; prostate and seminal vesicles; kidney; ureter; bladder; skin; connective tissues; bones; joints; muscles; tendons and tendon sheaths; blood and lymph vessels; heart; nasal cavity and accessory sinuses; larynx and trachea; lungs, bronchi and pleura; mediastinum and intrathoracic space; lymphatic system; spleen; thyroid gland; parathyroid glands; thymus gland; suprarenal gland; ear; visual apparatus; neck; chorda dorsalis vestiges; and the sacrococcygeal region.

This imposing list of subjects is set down here to emphasize the large scope of the book. A great profusion of references to the literature is tabulated but as so often happens when one author attempts to cover such a comprehensive field he has found it physically impossible to read and evaluate all of them. To offset this difficulty, material and opinions are freely borrowed from members of the staff of the Presbyterian Hospital in New York and the book really represents a cross section of the tumor work that is carried on in that institution.

It is assumed that chronic irritation plays an important rôle in the causation of cancer and in each section so-called precancerous lesions, many of which are attributed to irritation, are described. Symptoms and signs of the various malignant tumors are enumerated and methods of diagnosis are given in some detail. The diagnostic sections are much better than those devoted to therapeutic measures since, as the author freely admits, "It is doubtful if there exists today a single individual who could deal authoritatively with the manifold surgical operations upon every tissue in the body and at the same time deal with the complexities of the subject of radiotherapy." Although irradiation is given full credit and many statistics from the better centers are quoted, little is said of technique and it is evident that the author is more familiar with surgical procedures than with radiation therapy. However, the experienced radiotherapist will not consider this omission a serious one and the wealth of clinical and diagnostic information contained in this volume entitles it to a place on the desk in his examining room.

Charles L. Martin

Nasal Accessory Sinuses. By Frederick M. Law, M.D. (*Annals of Roentgenology*, Vol. xv. Edited by James T. Case, M.D.) Cloth. Price, $10.00. Pp. 215, with 225 illustrations. New York: Paul B. Hoeber, Inc., 1933.

It is our observation and belief that many

roentgenologists are content to examine the paranasal sinuses rather superficially and to be satisfied with reports of clouding or infection of cells and sinuses often vaguely located and described. This volume, therefore, has a very definite mission in raising the standard of roentgenography.

The subject matter throughout has been handled with a view to practicability. Instead of anatomical descriptions copied from standard textbooks there are careful descriptions and analyses of the normal sinuses and the variations as they are shown on the roentgenogram and may affect the surgical procedures.

To one who has not made a special study of the subject, it is surprising now much assistance the roentgenologist can give to the surgeon. More complete and careful operations are possible when the depth of the sinuses, the presence of septa or pockets, the presence of unerupted teeth and numerous other possible variants are known.

Law considers exact and painstaking technique an absolute prerequisite for satisfactory diagnosis. The reasons for emphasis on roentgenograms of good quality and made in the proper positions are explained. The use of fine focus tubes, sufficient distance, absolute immobility and careful positioning are essential. The Potter-Bucky diaphragm is not only not recommended but its use discouraged as it tends by increasing contrast to obscure soft tissue detail. Stereoscopy is important, especially in the lateral projections, for study of the ethmoids. Various positions are described and illustrated.

Under diagnosis the author discusses the differentiation of acute from chronic conditions, a decision which too few diagnosticians attempt. The author believes that in many cases differentiating signs between acute and chronic, or purulent, catarrhal, and hyperplastic sinusitis can be demonstrated, as well as the rarer conditions such as neoplasms of the bone or soft tissues. The causes of errors and inadequacies of diagnosis are discussed.

The volume includes more than two hundred and twenty-five plates illustrating all conditions, and their excellence is on a par with the high standard set for the *Annals of Roentgenology*.

By a careful study of this book, the roentgenologist cannot fail to improve his diagnoses, with benefit to himself, to the surgeon and most important, to the patient.

E. W. Hall

Grundlagen und Praxis der Röntgenstrahlendosierung: Dosismessung und Dosisfestsetzung. Von Prof. Dr. Med. H. Holthusen, Leitender Oberarzt am allgem. Krankenhaus St. Georg, Hamburg, gemeinsam mit Dr. Med. R. Braun, Assistant am Strahleninstitut des allgem. Krankenhauses St. Georg, Hamburg. Paper, price M. 18.—; bound, M. 19.60. Pp. 249, with 152 illustrations and 27 tables. Leipzig: Georg Thieme, 1933.

Beyond any question this book presents the most complete treatise yet published on the physical problem of roentgen-ray dosage, dealing not only with the fundamental principles involved, but also with the strictly practical problems of clinical dosage. While it reflects a little more of the European concepts of dosage determination, its close study should be of inestimable value to the roentgen therapist. Ample references are given to permit further study of the original papers. The book is divided into five main sections, the first of which (29 pp.) deals with general physics of roentgen rays. The reader is here given the fundamentals of roentgen-ray production with particular view to the medical applications which follow. A minimum of mathematical treatment is used. The second and third sections (120 pp.) take up the problem of dosage determination, after very clearly setting forth what the problem consists of. They deal at some length with the mechanism by which roentgen radiation is utilized in biological material. An endeavor is made to avoid the pitfalls encountered in our thinking of biological actions in terms of real and effective energy, a general misunderstanding of which, in the past, has led to false interpretations of the effect of different wave lengths. The rôle of scattered radiation is given its full merit. From this, the authors pass to the physical means of evaluating dosage through the use of air ionization measurements, describing the standard method of determining the roentgen. The question of quality measurement is taken up in great detail terminating with specific recommendations in favor of the half-value layer methods. This is followed by description and discussion of a number of com-

mercial "dosage meters" showing the application and limitations of each. Details regarding the calibration and control of calibration of such instruments are given. This section is limited almost entirely to foreign instruments, although the principles apply to all kinds. The fourth section deals with the dosage problem from the physical-biological viewpoint, starting out with the problem of depth dosage and water phantom measurements wherein the influence of such factors as quality and field size are considered in great detail. The influence of the various factors on skin reaction is developed in proof of the efficacy of the physical measurements involved. This includes the use of biological test material such as *Drosophila* eggs and seedlings. After having shown the ideal relationship of dosage measurement to biological reaction, the practical administration of radiation to the human body is discussed, including the use of multiple port technique. Their final chapter, while the shortest, seems one of the most important in that it gives simple numerical examples involving all of the earlier principles laid down. This should be of inestimable value to the physician who is often not trained in the use of as much physics as he is frequently expected to employ. The book, as a whole, is filled with tabular data and curves in such detail as to amount amost to a reference handbook.

Lauriston S. Taylor

Radiodiagnostico en la Infancia; tomo primero: pelvis y extremidal inferior. By Manuel and Francisco Arce, Radiologists to the Hospital del Niño Jesus, The Pediatric Clinic of the Faculty of Medicine of Madrid and the Asilo de San Rafael, with a preface by Dr. D. Enrique Suñer, Catedrático de Pediatría de la Facultad de Medicina de Madrid. First Edition. Cloth. Pp. 285, with 210 illustrations. Madrid: Ediciones Boro, 1933.

This book, the first volume of a system on the roentgen diagnosis of the diseases of childhood, falls naturally enough into two parts. In the first part there is a detailed consideration of the normal roentgen anatomy of the pelvis and lower extremities, and in the second part there is a description of the findings in the various pathologic conditions. Each one is illustrated by excellent reproductions of prints of roentgenograms taken in that projection which best brings out the characteristics of the lesion. Since the text is occasionally several pages out of step with the illustrations under discussion, one wonders whether the addition of an explanatory legend to the illustrations might not make the pictures of even greater value to the reader. Throughout the whole book, as was emphasized by Suñer in his preface, the practical clinical side of roentgenology is brought into the foreground by the authors. Although this book is primarily designed to fill a gap in Spanish roentgenologic literature, it seems to be a valuable reference book not only for Spanish-speaking roentgenologists and pediatricians but also for all of those specialists whose work involves the study and interpretation of the sometimes peculiar conditions found in childhood, and for whom helpful information is not elsewhere so easily available in a single book. The makeup of the book is so attractive that one reads it rather than studies it.

DEPARTMENT OF TECHNIQUE

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THE USE OF CHEST ROENTGENOGRAMS TAKEN WITH BREATH HELD IN EXPIRATION*

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CHEST roentgenograms are routinely taken with the subject holding his breath in inspiration. During this phase of respiration the lungs are normally enlarged by an increased content of the radiolucent air; opaque structures in the chest, normal or abnormal, are generally brought out to better advantage in chest films made in inspiration.

However, there are certain regions of the chest which are normally enlarged in expiration, and there are many lung affections in which the breathing is vicarious, i.e., air is taken in in expiration and is expelled during the normal phase of inspiration. In these conditions, films taken in expiration may furnish valuable information additional to that furnished by the film taken in the usual manner.

PHYSIOLOGICAL CONSIDERATIONS

The chest is not uniformly supplied with musculature, and the ribs vary in length and mobility, so that the respiratory capacity varies in the different portions of the lungs. The intrapleural pressure also varies in the different regions of the chest.[3] The first rib is the least mobile and the intercostal muscles begin with the first interspace while the lung extends for a considerable distance cranial to the level of the first interspace. There is no muscle available to activate the mediastinal regions of the lungs. During tranquil respiration the mediastinal and apical regions, including the lung adjacent to the first interspace, undergo but slight change; during more active respiration these regions deflate in inspiration and inflate in expiration. The expiratory inflation is aided by the narrowing of the glottis which normally occurs during expiration.

Of the muscles used in deep respiration, the expirators (abdominal muscles, latissimus, etc.) are attached to the lower ribs and lower sternum, while the inspirators (sternomastoid, scalenus, etc.) activate the upper ribs and the upper segment of the sternum. In forced breathing there results an interchange of air between the basal and apical portions of the lungs. In forced expiration, the trachea and glottis being narrow, the air driven from the lung bases is but partly expelled into the atmosphere; part of it is forced into the apical and mediastinal regions of the lungs. Conversely, during deep inspiration, the more active portions of the lungs take in air not only from the atmosphere but also from the less active portions of the lungs. This vicarious breathing becomes very pronounced in spasm of the glottis or bronchi (asthma, whooping cough, etc.) and in all cases of obstruction along the respiratory passages (tumors, adenoids, singing, crying of infants, whistling, wind instrument blowing, etc.).

This paradoxical breathing is the cause of the dyspnea and cyanosis observed in asthma,[5] and is an important factor in the production of pulmonary emphysema;[9] it is very manifest in open pneumothorax,[10] in hernia of the lung;[13] after thoracoplastic operations of the chest,[1] and after multiple

* Published with the permission of the Medical Director of the U. S. Veterans' Administration, who assumes no responsibility for the opinions expressed, or the conclusions drawn by the writers.

rib fractures.[12] Vicarious breathing has also been described in pneumonia[4] and in tuberculous cavities.[11]

During physical examinations one expects to see the supraclavicular regions collapse during inspiration, and one is gratified to see the lung apices inflate evenly during cough. Likewise, during roentgenoscopic examinations we expect the lung apices to "light up" on coughing before we pronounce them normal.

Most pathological conditions in the lungs are associated with areas of atelectasis and areas of emphysema, and these areas are subject to paradoxical breathing, i.e., they enlarge on expiration. For this reason we auscultate for râles during cough.[2]

Vicarious breathing is the usual cause of the interbronchial spread of infection in the lungs, and is the process by which we endeavor to reinflate the collapsed lung following empyema.[14]

Plainly, there is a variety of conditions in which certain portions of the lungs have a greater air content in expiration than in inspiration.

ILLUSTRATIVE CASES

Case I. Clinical findings: Signs of cavity in right upper lobe. Coarse moist râles above 3rd rib and 6th dorsal vertebra on right side. Tubercle bacilli in the sputum. The routine roentgenograms showed the cavity and the tuberculous infiltration which was apparently limited to the region above the right 2nd rib. The extent of involvement disclosed by the films was less than that revealed by physical examination. The film made in expiration shows more pathology: there is the typical tuberculous mottling with numerous annular shadows in the 2nd and 3rd interspaces on the right side. (See Figs. 1*a* and 1*b*.)

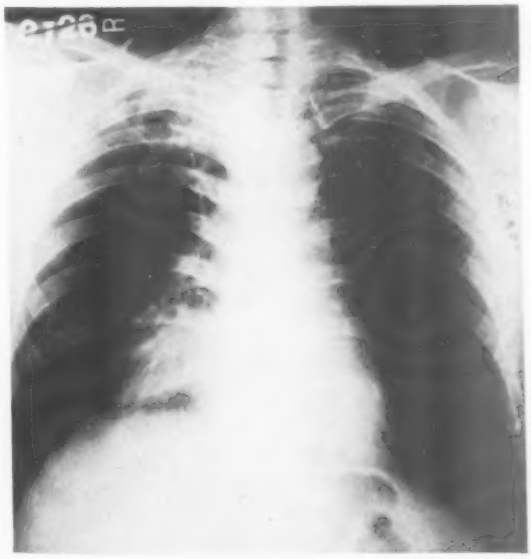

Fig. 1*a*. Case I. Film taken in inspiration. The abnormal changes are apparently limited to the upper two interspaces on right side.

Fig. 1*b*. Case I. Film taken in expiration at same sitting as Figure 1*a*. Note the typical mottling of tuberculosis and numerous annular shadows in the second and third interspaces. The apices have greater air content in expiration and the upper two interspaces are widened in this phase of respiration.

Case II. Artificial pneumothorax right. The cavity in the right upper lobe remained open in spite of moderate positive pressures. During deep expiration the intrapleural pressure varied between positive 16 and positive 20 cm. of water, on March 30, 1932. Roentgenoscopic observations on that day showed that during deep expiration the cavity was fairly well compressed; the heart was displaced to the left, and the mediastinum herniated into the left hemithorax. (See Figs. 2*a* and 2*b*.) These observations have guided us in the management of this and other cases.

Case III. The man suffered a gunshot wound in the chest in 1918. During the fall of 1928 the

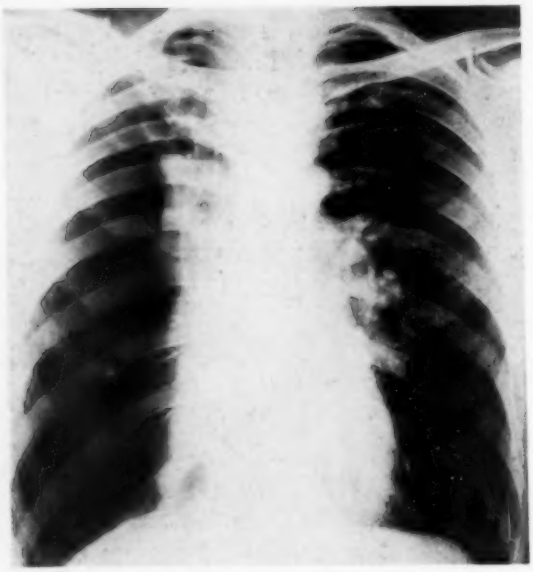

FIG. 2*a*. Case II. Inspiration. Artificial pneumothorax right. Large cavity, uncompressed, containing fluid, in first right interspace. Ballooning of the right pleural cavity into the left hemithorax opposite third interspace.

physical findings were those of chronic bronchitis. The roentgenograms made in inspiration showed undue transparency of the left base with the left half of the diaphragm low and flat (obstructive emphysema). The cause of the unilateral emphysema and bronchitis was not apparent. The film made in expiration shows good deflation of the right base and poor deflation of the left (emphysema). The transverse diameter of the left lung is increased encroaching on the mediastinum which is compressed in expiration. A metallic foreign body is now visible in the mediastinal region of the left lung.

CASE IV. This war veteran applied for an increase in pension on account of a bullet in the left lung. He claimed disabling effort dyspnea, and periodical attacks of hemoptysis. The man looked well and there were no abnormal physical signs in the chest. The film made in inspiration shows a bullet in the left lung at a considerable distance from the vital structures of the hilus. The film taken in expiration shows that the bullet impinges on the lower lobe bronchus during expiratory efforts. These films also show poor ventilation of the left lower lobe (obstructive emphysema). The roentgenologic study of this case during straining and forced expiration made his subjective complaints more creditable and acceptable for pension purposes. (See Figs. 3*a* and 3*b*.)

CASE V. Complaints: Shortness of breath on exertion; asthma-like breathing at night. Physical examination of the chest showed a few scattered musical râles; no other abnormal findings. The thyroid gland was visibly enlarged. The film made in inspiration shows the lungs very transparent and free of abnormal deposits. The trachea is displaced to the left and the superior mediastinum appears veiled, as if by thickened pleura. The film made in expiration shows complete clearing of the haziness in the mediastinum. The neck is much larger in expiration than in inspiration. Obviously there is a goiter which descends into the chest in inspiration, and is pushed up into the neck during expiration. This migration of the goiter with respiration was later confirmed by physical examination.

CASE VI. Complaints: Increasing dyspnea and productive cough during the past ten years. There was labored breathing at rest, slight cya-

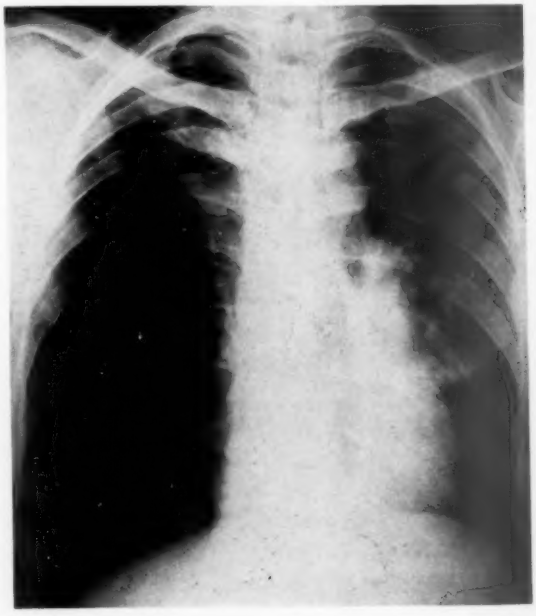

FIG. 2*b*. Case II. Expiration—taken at same sitting as Figure 2*a*. There is much better compression of the right lung and the cavity is obliterated. Marked displacement of the heart to the left. The hernia is larger and appears higher; new hernia has appeared in the lower mediastinum; this illustrates the enlargement of the mediastinal space in expiration. The apical regions and the first interspaces are larger in expiration.

nosis, clubbing of the fingers. The chest was barrel-shaped, and there was hyperresonance over the lung bases with feeble breathing and coarse moist râles.

The roentgenogram made in inspiration showed symmetrical changes in the lung bases; these were abnormally transparent and devoid of all markings from the 4th interspace downward. Above the transparent areas there were numerous transverse linear densities suggesting compressed lung. The appearance was that of bilateral partial pneumothorax. The film made in expiration showed the transparent areas much enlarged, proving that we were dealing with air spaces which communicated with bronchi, and which were breathing paradoxically. The latter film helped to establish the diagnosis of bullous emphysema.

Case vii. The man had undergone three operations for recurrent empyema and lost segments of four ribs. At the time of examination there was no discharging sinus; the pulse and temperature were normal, and there were no signs of recurrence of the empyema. However, there was labored breathing at rest and cyanosis. There were two large scars in the anterior axilla and one beneath the scapula on the right side; the posterior scar was drawn in with each inspiration and relaxed on expiration. Normal breath sounds were present above the 3rd rib and 8th dorsal vertebra on the right side and throughout the left side. The cause of the patient's dyspnea was not apparent. Examinations of the heart and of the kidneys gave normal findings. The film made in inspiration showed a large left lung and a contracted right lung rendered hazy by thickened pleura; signs of surgical interference with the 4th, 6th, 8th, and 9th ribs; the right costophrenic angle obliterated. The film made in expiration shows increased transparency at the right base; the heart is displaced to the left, and the right costophrenic angle is quite normal in size. In other words, there was an increased air intake in the right base during expiration. This vicarious breathing was the cause of the respiratory distress.*

Fig. 3*a*. Case iv. Inspiration. Lipiodol in left lower lobe. Bullet in left perihilar region. Left lower lobe is emphysematous.

Fig. 3*b*. Case iv. Expiration—taken at same sitting as Figure 3*a*. Good deflation of right base, poor deflation of left base (obstructive emphysema). The bullet is seen in relation to lower lobe bronchus in expiration. During expiration there is increased air content in the apices and in the left mediastinal region. The first interspaces are wider in expiration.

* For further illustrations on this subject, the reader is referred to articles in the *American Review of Tuberculosis*,[6,7] and in the *Archives of Internal Medicine*.[8]

SUMMARY

The lung apices and the mediastinal portions of the lungs normally expand on deep expiration; the first interspace always enlarges in expiration; there are numerous pathological conditions of the lungs and chest wall characterized by paradoxical breathing, i.e., by increased air intake during expiration. For these reasons chest roentgenograms made with the breath held in expiration frequently give valuable information, additional to the information gleaned from films made in inspiration.

Case reports are cited to illustrate the value of this procedure in tuberculosis, pneumothorax, foreign bodies in the lungs, emphysema, substernal goiter, and in extensive rib resections.

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Vol. XXXI, No. 2

THE OCCIPITAL VIEW : MODIFIED TECHNIQUE

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A RECENT report by Leonard and George[1] illustrates the use of a curved cassette to study the base of the skull. For several years I have used a technique which gives a similar view with the flat cassette. This is not an original method, but is a modification of the occipital technique of Hirsch,[2] Jerman[3], and others.

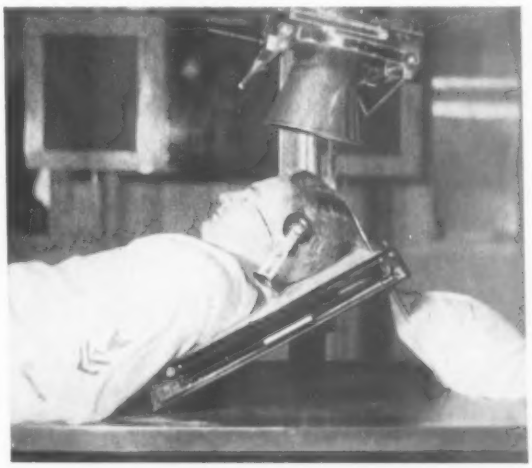

Fig. 1. Position for occipital view.

Fig. 2. Occipital view, 23°.

A flat Potter-Bucky diaphragm is used, but a tilting curved Potter-Bucky may be used; the Potter-Bucky must be placed so that the grid travel is transverse.

Position of Patient. Occiput to Potter-Bucky, with the head flexed; Potter-Bucky tilted to conform as nearly as possible to occipital surface of the skull, with the occipital protuberance just above the center of the film. The degree of tilting of the Potter-Bucky is varied to suit the shape of the skull; the head is flexed in order to flatten out the line of the occipital surface and the neck as much as possible. The head is fixed in position by clamps.

Fig. 3. Occipital view, 30°.

Tube Position. Seven inch cone, tube

tilted caudad 23° or 30° to auriculo-canthal line; central ray directed in median line, above frontal eminences, to center of film.

Exposure. The penetration is increased about 5 per cent and the time about 10 per cent over the regular anteroposterior technique. This will vary with the types of grids and cassettes used.

The resulting roentgenogram shows good detail of the occipital bone including the margin of the foramen magnum, and also the mastoid and petrous parts of the temporal bones. With the 23° tube tilt the petrous bone is defined better, and with the 30° tilt there is a better view of the occipital bone, and the foramen magnum.

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ROENTGENOGRAPHY OF THE SPINE

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IN roentgenograms of the spine, the detail is obscured somewhat by secondary radiation which passes through the grid and by secondary rays from the grid itself. To improve detail, I have used a lead diaphragm placed over the surface of a curved Potter-Bucky. This diaphragm is made by cutting out a section 6″ × 18″ from the center of a sheet of lead or lead rubber of the size to cover the surface of the Potter-Bucky, which will require a sheet about 30″ × 22″.

The slot in the diaphragm is centered on the Potter-Bucky, and a 14″ × 17″ or 11″ × 14″ film placed so that one-half of the film is centered under the slot. After making the first exposure, the film is turned to use the second half for the lateral or another section of the spine. After processing, the film is cut so that the two halves may be viewed in proper position. The 7″ × 17″ films and cassettes may be used instead of the larger films.

Without any other change in technique the use of the diaphragm results in remarkable improvement of detail; and the film cost is reduced considerably. This diaphragm technique is in effect a modification of the oblong cone method with the added advantage of the elimination of most of the secondary radiation.

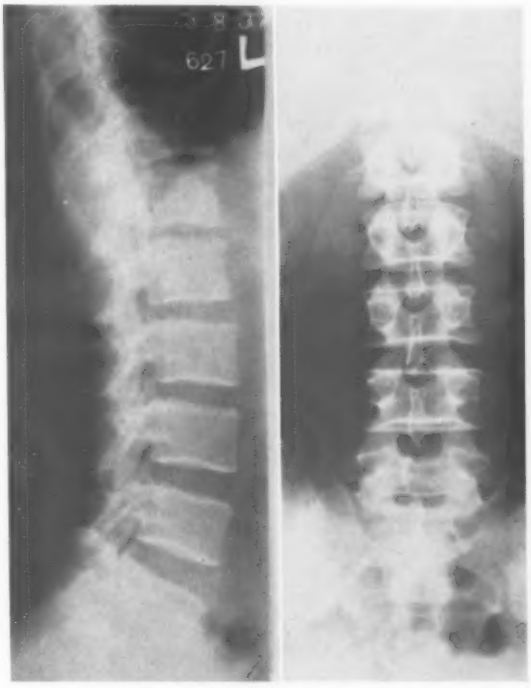

FIG. 1. Lumbar spine, single 14″ x 17″ film, cut.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN AND RADIUM THERAPY

Samek, Julius. Zur Frage des Röntgenschadens in der Dermatologie. (The question of roentgen injury in dermatology.) *Strahlentherapie*, 1932, *45*, 782–788.

Roentgen injury in dermatology can best be avoided by using irradiation only on strict indications, by exercising care in the dosage, though no uniform scheme can be given but the dosage must be adapted to the individual case, and by using only bland salves for the after-treatment of the irradiated parts of the skin.

Roentgen treatment is strictly indicated only in cases in which it is either the sole effective treatment or is admittedly very much superior to any other method of treatment. It may be absolutely indicated in angiomas, plantar warts, condyloma acuminatum, keloid, plastic induration of the penis, kraurosis vulvae, palmar and plantar hereditary keratoma, mycosis fungoides, fungous diseases of the scalp in children and scleroderma. It is relatively indicated in conditions in which irradiation is only slightly superior to other methods of treatment but the physician is convinced that in the individual case its use is to be preferred. Among such conditions are actinomycosis, subacute and chronic eczema and hyperidrosis.

In cases in which results may be expected from roentgen therapy but its only advantage over other forms of treatment is that it is cleaner and more convenient, medical treatment should be preferred, as a general rule, reserving irradiation for exceptional cases. The author has almost given up radiotherapy in lupus vulgaris. Both the primary and secondary forms of scrofuloderma may be considered relative indications. In tumors of the skin he removes the tumors as far as possible with cold or by means of electrotomy and then irradiates with radium or more rarely with roentgen rays. Irradiation is contraindicated in conditions in which its only value would be cosmetic and there is some danger of injury, such as hypertrichosis and many forms of cellular and hyperplastic nevi.—*Audrey G. Morgan.*

Lorey, A., and Schaltenbrand, G. Pachymeningitis nach Röntgenbestrahlung? (Pachymeningitis after roentgen irradiation?) *Strahlentherapie*, 1932, *44*, 747–758.

The patient was a seven months child. She and her sister were irradiated for trichophytosis of the scalp. The whole scalp was irradiated in seven fields from the 3d to the 9th of April. A symmetry apparatus was used, metro tube, 170 kv., 2 ma., 23 cm. focus-skin distance, 17 minutes, surface dose 85 per cent of a skin erythema dose. The cathode was heated with an accumulator battery. The tube was gauged with an ionometer.

The sister, who at that time was two and a half years old, was found dead after the third irradiation; the patient who at that time was five years old showed total epilation three weeks after the irradiation. After about three months hair grew on the left side of the head again but no growth took place on the right side. The scalp on the right side now shows typical signs of injury from irradiation with telangiectases, etc. A year after the irradiation the patient fell one day and struck her head on the floor. After this increasing headache developed and finally loss of consciousness, paralysis of the left side of the body, vomiting, epileptic attacks and fever. From that time on she had epileptic attacks and weakness of the left side. About a year later she had a second acute attack similar to the first. As years passed the attacks increased and absences occurred. The left half of the body was stunted in growth. At the age of twelve the child was sent to the authors' clinic. Examination showed retarded growth of the left arm and spastic symptoms of the left arm and both legs, more marked on the left. Roentgen examination of the skull showed atrophic changes of the bones covering approximately the injured brain area and superficial calcium deposits inside the skull also corresponding approximately to the atrophic skin area and atrophic bones. The encephalogram showed the right ventricle larger than the left, indicating atrophy and contraction of the right hemisphere.

The authors conclude that this patient suf-

fered an injury of the scalp, skull bones and meninges from the roentgen irradiation over a certain area and that a pachymeningitis of this area developed. This resulted in an injury of the cortex which manifested itself in inhibition of growth, epileptic attacks and spastic pareses. The inflammatory-degenerative process in the meninges finally caused calcifications. Though no other cases have been published in the literature the authors think more caution should be used in dosage in irradiating the heads of children than has heretofore been the custom. —*Audrey G. Morgan.*

PONZIO, M. Über die Kombination der Röntgen- und Licht-therapie. (The combination of roentgen and light therapy.) *Strahlentherapie*, 1932, *45*, 81–85.

The predominant action of ultraviolet rays is photochemical, that of roentgen rays photoelectrical. The ultraviolet rays act chiefly on the molecule and the electrons of the peripheral tracts in the atom, while the roentgen rays penetrate to tracts nearer the center of the atom and cause much more complicated changes in electron balance. From the biological point of view the ultraviolet rays exercise chiefly a stimulant action while the roentgen rays have more of a destructive action on cells. The two kinds of rays should supplement each other in combined treatment. The ultraviolet rays exercise chiefly a surface action because of their greater absorbability, while the roentgen rays, particularly those of high potential, exercise a deep action. Because of their photochemical action the ultraviolet rays are bactericidal. They also have a very energetic action on metabolism, particularly on processes of oxidation, the calcium and phosphorus balance in the blood, glycemia and the protein content of the blood. Therefore a combination of roentgen and ultraviolet irradiation seems to be particularly indicated in forms of disease in which destruction of especially radiosensitive cells is to be combined with a stimulating action on metabolism, as in tuberculosis of the bones, glands, skin, etc. For the present, norms have not been established with regard to the best ways of combining the rays; this will have to be determined clinically in each case. Successful results have also been obtained in tuberculosis of internal organs, particularly in hyerplastic peritoneal forms and intestinal and pararenal tuberculosis. In tuberculosis of the lungs the technique is particularly delicate; apparently this method of treatment is indicated only in the productive forms while it is contraindicated in the exudative forms. Further clinical and experimental research is required in this field to determine dosage and the relative amounts of roentgen and ultraviolet irradiation.

The combined treatment is also useful in many blood diseases in which certain forms of cells must be destroyed and others stimulated. So far the technique in these cases is empirical. There are immense possibilities also in the combined treatment of disturbances of metabolism. Valuable work has already been done in cases of nervous asthma, different forms of rheumatism and diseases of the glands of internal secretion and also in tumors, where the action of the roentgen rays is supplemented by the stimulant action of the ultraviolet rays. The combined treatment should also prove of value in skin diseases of different kinds and in alleviating pain in neuralgias.—*Audrey G. Morgan.*

BÖHM, ALEXANDER. Uber die Röntgenbestrahlung als unspecifische Reiztherapie. (Roentgen irradiation as a nonspecific stimulant therapy.) *Strahlentherapie*, 1933, *46*, 130–136.

In 1924 Heidenhain and Fried reported their good results in the treatment of acute and chronic inflammations with smaller doses of radiation than had been in use before that time.

The author discusses the mechanism of these results and reports experiments which show that irradiation increases the production of immune bodies and inhibits the action of impedin, which is a form of biological energy that inhibits agglutination, precipitation, bacteriolysis, phagocytosis and complement production.

He also discusses secondary irradiation and concludes that the secondary irradiation that originates from cathode irradiation is transformed into a kind of irradiation that is related physically and biologically to cathode irradiation, and the direct bactericidal action is to be attributed only to this irradiation while the therapeutic effect is brought about by nonspecific immune actions.—*Audrey G. Morgan.*

STEINITZ, E. Ueber die Wirlung kleinster und grösserer Röntgendosen bei schwerer Blutkrankheiten. (Effect of very small and larger doses of roentgen rays in severe blood diseases.) *Strahlentherapie*, 1932, *44*, 739–746.

Three cases are described and roentgen dosage discussed in connection with the results. The first was a case of fever of unknown type which the author calls an agranulocytic five-day fever. The patient had two attacks with an interval of three years between them. During the first illness two series of irradiations of 20 per cent of a skin erythema dose each were given over six fields, both upper arms, both thighs, the sternum and an area of resistance on the abdomen. During the second illness three irradiations were given over five fields—the sternum, both legs and both thighs—the total dose for all three being only 20 per cent of a skin erythema dose. The doses were moderate in both cases but the author suggests that the better results the last time may have been due to the lower dosage. He believes low dosage is indicated in such cases. The disease was evidently caused by crises of some kind in the blood-forming organs as no parasites of any kind could be found and in every attack of fever the neutrophil cells fell to a minimum and rose again in the fever-free intervals.

The second case was one of myeloid leucemia with extraordinarily high leucocyte counts. The patient, a young man aged twenty-six, had a leucocyte count of 215,000 in July, 1930. After a first series of irradiations with a total dosage of 950 r the leucocytes rapidly fell to normal and this good condition persisted for seven months. The cells then rose to 150,000; a second series of 6 irradiations with a total of 1,200 r was given, after which they fell to 18,000. This lasted only two months after which they again rose to 150,000. A small series of 2 irradiations with a total dose of 410 r was given which decreased the number to 13,000. When this number rose after three weeks to 33,000 two more roentgen doses were given with a total of 440 r. The leucocytes fell to 12,000 but this was followed by an extreme fall of erythrocytes and hemoglobin. The patient rapidly lost strength and died within three weeks. Autopsy showed the pulp of the spleen almost entirely disappeared. The author does not know whether this was only the normal end of the disease or whether the end was hastened by the last irradiation. A blood transfusion was given toward the last too, which may have had a bad effect as the function of the spleen was practically destroyed. As there were only 33,000 leucocytes and the former irradiations had caused such extreme decrease of leucocytes he thinks the last irradiation should at least have been smaller.

The third case was one of particularly severe lymphatic leucemia with severe anemia. Even a small dose of 75 to 80 r made both the red and white blood picture worse after they had been improved by blood transfusion and arsenic. A second dose of 75 r was given later in the hope of improving the condition but the patient died about four months afterward.—*Audrey G. Morgan.*

Schloss, Wilhelm. Über Radiumbestrahlung der Gefasse bei Zirkulationsstörungen. (Radium irradiation of the blood vessels in circulatory disturbances.) *Strahlentherapie*, 1932, *45*, 793–795.

It has been shown that irradiation dilates the vessels and causes hyperemia. The author therefore tried radium therapy in circulatory disturbances such as intermittent claudication, Raynaud's disease and diabetic gangrene. He had an apparatus made of Columbia paste to fit over the dorsalis pedis, anterior, and posterior tibial, popliteal and femoral arteries. The needles, filtered through 0.5 mm. platinum, were arranged in this along the course of the arteries, the distance of the radium from the skin being 5–7 mm. The intensity of the radium needles was only about 5 microcuries-destroyed per hour, so the daily dose was 3–4 millicuries-destroyed and the total irradiation lasted ten to fourteen days. He had good results in 16 cases and failure in 5. The successful cases were 4 of intermittent claudication without external changes, 3 of intermittent claudication with beginning changes in the toes, 4 of endarteritis obliterans with gangrene of the toes, 3 of arteriosclerotic gangrene and 2 of diabetic gangrene. Of course the only result that can be expected is dilatation of the arteries and hyperemia. If the vessels are obliterated or show severe anatomical changes recovery cannot be expected.—*Audrey G. Morgan.*

Altschul, Walter. Bemerkungen zur Röntgentherapie des Erysipels. (Roentgen therapy of erysipelas.) *Strahlentherapie*, 1932, *45*, 167–170.

The technique seems to have a great effect on the results of roentgen therapy in erysipelas. The author believes that roentgen therapy is the method of choice if small doses and very low tensions are used. Erysipelas patients gen-

erally have a high fever and cannot be brought to the hospital so he has used a portable apparatus, an old type of the heliodor apparatus, the transformer of which weighs about 150 kilograms; its maximum tension is 65 kv. effective, that is, 93 kv. vertex tension. The irradiations were given with a Dofok diagnostic tube with water cooling and a filtration of 3 mm. aluminum; with 30 cm. focus-skin distance the necessary dose of about 2 1/2 H was reached in thirteen minutes. This tension is much lower than any ordinarily used in modern roentgen therapy.

He has had successful results in all of his cases but one and this patient was in practically a moribund condition when the irradiation was begun. He has also had successful results in chronic recurrent cases. He describes one case in detail in which after cure of the erysipelas a bland abscess developed in the groin followed by a new outbreak of erysipelas, which was also cured by further irradiation. He thinks that in erysipelas of the extremities not only the diseased skin should be irradiated but also the regional glands about a month later.—*Audrey G. Morgan.*

HOFFMANN, CARL. Der lymphoepitheliale Tumor. (Lympho-epithelial tumors.) *Strahlentherapie*, 1932, *45*, 601–644.

Lympho-epithelial tumors are dysontogenetic branchiogenous tumors showing the structure of lympho-epithelial tissue. They may occur in all organs the development of which is related to the branchial pouches. They occur chiefly in the epipharynx and mesopharynx and more rarely in the hypopharynx and the thymus. They cannot be differentiated clinically from other tumors of these regions and histological examination is necessary for accurate differential diagnosis. In any suspicious tumor of these regions an exploratory excision and histological diagnosis should be made at once and roentgen treatment given if the tumor proves to be lympho-epithelial in nature, as these tumors are particularly sensitive to irradiation and the results are excellent if irradiation is given early. They grow slowly at first and the general condition is not seriously affected as it is in sarcomas and carcinomas. They do not cause serious clinical symptoms until they have grown to such a size that they cause mechanical disturbance by pressure. Often the regional glands enlarge before there is any demonstrable primary tumor. The prognosis in this stage is good. Later there is intense infiltrative growth of the tumor and gland metastases, ulceration and increasing fixation of the primary tumor with local mechanical disturbances. The prognosis is still favorable for tumors of the mesopharynx, less so for those of the hypopharynx and doubtful for those of the epipharynx. In the last stages there is extensive deep ulceration of the tumor with infiltration of all the region, extensive multiple enlargement of glands, frequently distant metastases and impairment of the general health. The prognosis is bad in this stage.

Surgical treatment is contraindicated on account of the danger of disseminating tumor cells. Roentgen irradiation is the treatment of choice, preferably in the form of fractional irradiation. It is doubtful whether Coutard's protracted fractional method is any better than simple fractioning.

Only approximate dosage can be given. The doses must be larger for tumors of the epipharynx than for those of the mesopharynx and larynx because of the greater depth of the focus. On external irradiation there is generally a distinct decrease in the size of the tumor after 3 daily irradiations of 100 r with 0.5 mm. zinc filter and 180 kv. After 6–8 such treatments generally little or nothing is left of the tumor and the irradiation can be stopped. On intraoral irradiation a dose of 100 r with 0.5 mm. zinc filter and 180 kv. is given on four successive days, and sometimes a supplementary dose of 100 r is given 6 to 8 times on an external field. The dosage depends primarily on the reaction of the tumor. After four to six weeks another series is given, no matter whether there are any residues or recurrences or not. Careful observation of the reaction is particularly important in tumors of the mediastinum which on account of their size and greater content in lymphatic cells break down more rapidly and extensively than other lympho-epithelial tumors.

With early and correct treatment the prognosis is comparatively good.—*Audrey G. Morgan.*

STEINER, GEORG. Strahlenerfolg bei zwei Fälle maligner Schilddrüsentumoren. (Results of irradiation in two cases of malignant thyroid tumor.) *Strahlentherapie*, 1932, *45*, 796–800.

A woman aged sixty-seven had a malignant goiter that surgeons had declared inoperable with processes extending into the left supraclavicular fossa. She had dyspnea, difficulty in swallowing and local and neuralgic pain. She was irradiated on 3 neck fields, right and midcle 8×10 cm., left 10×12 cm., one field being irradiated a day for three successive days, and after a week's interval the series repeated. She was then irradiated over the right mediastinum in front and behind. A total of 1,736 r was given on the neck fields; 180 kv., 4 ma., 30 cm. focus-skin distance, 0.5 mm. zinc and 2 mm. aluminum filter. The depth dose at 10 cm. was 26 per cent, at 5 cm., 55 to 56 per cent. This resulted in complete cure of the subjective symptoms and great decrease in the size of the primary tumor and the processes. This result has persisted for a year and a half.

A woman aged fifty-six had undergone roentgen castration for myoma of the uterus some years ago. In the spring of 1931 malignant goiter developed and grew rapidly. She came for treatment suffering with dyspnea and slight hyperthyroid symptoms. Exploratory excision after painting with iodine showed sarcoma. A severe iodine dermatitis developed which delayed irradiation five weeks. Iodine should not be used in painting for exploratory incision when malignancy is suspected as it is incompatible with irradiation. She was irradiated the end of May over 3 neck fields with a total of 44 H or 3 1/2 erythema doses on the surface, and 2 thorax fields with 72 H or 6 erythema doses fractionated over ten days by Holfelder's modification of Coutard's method; 180 kv., 30 cm. focus distance, 0.5 mm. zinc and 2 mm. aluminum filter. The subjective symptoms were cured and the primary tumor and mediastinal metastases greatly decreased in size. At the end of September she was feeling quite well. In view of the advanced stage of the disease permanent cure is not to be expected.—*Audrey G. Morgan.*

Schinz, Hans R. Operative und radiotherapeutische Behandlung der Krebse. (Operative and radiotherapeutic treatment of cancer.) *Strahlentherapie*, 1933, *46*, 7–71.

Schinz discusses the 350 cases of malignant tumor treated by surgery or radiotherapy or a combination of the two at the Roentgen Institute and the Surgical Clinic of the University of Zurich in 1931 and the cases that have been re-examined from earlier years, bringing the total up to 476, of which 139 were free of symptoms at the end of 1931.

He discusses the results of surgery and radiotherapy based on the details of these cases and others reported by leading surgeons and roentgenologists. He concludes that radiotherapy is primarily indicated in both operable and inoperable stages of skin carcinoma, carcinoma of the lips and of the cervix; also in lymphadenoid sarcomas, round cell sarcomas and all tumors of the pharynx. He calls these the left wing. Tumors of the right wing are those in which surgery is indicated in the operable stage. These include carcinomas of the stomach, large intestine and rectum, kidney, bladder and prostate and probably also carcinomas of the esophagus, liver, bile ducts, and pancreas, and malignant tumors of the lungs, though surgery also has given very poor results in the latter. Between these two wings is a group of malignant tumors in which combined treatment is indicated in the operable stage, while in the inoperable stage radiotherapy is to be used, at least in the beginning. This group includes tumors of the mouth, jaw, thyroid and the majority of carcinomas of the breast, ovary and vagina.

The right wing is as yet more numerous than the other groups as it includes cancer of the stomach which is the most frequent of all cancers.

The article contains a wealth of interesting and valuable detail in regard to the author's own cases and tables showing the results at the Radiumhemmet in Stockholm and the Radium Institute in Paris.—*Audrey G. Morgan.*

Arndt, Julian, and Gloor, W. Resultate der Röntgenbestrahlung bei chronischen Leukämien. (Results of roentgen treatment in chronic leucemias.) *Strahlentherapie*, 1932, *44*, 715–738.

The results of combined arsenic and roentgen treatment in 39 cases of chronic myeloid leucemia and 26 cases of chronic lymphatic leucemia are discussed and compared with those of arsenic treatment alone and roentgen irradiation alone. It was found that better results were obtained in both forms of leucemia with the combined treatment than with either one alone. The treatment has to be adapted to each case—no routine plan can be given.

In chronic myeloid leucemia there are three

stages, differentiated by the clinical picture and the sensitiveness to irradiation. In the first stage arsenic treatment is the chief resource, the drug being given both by mouth and by injection. The preparations have to be changed often and the dose may be increased to as much as 15 to 20 mg. arsenous acid given by injection. Arsylen "Roche" and arsacetin are given by mouth. Roentgen therapy may be used in this stage also, preferably in the form of simple fractional treatment. In the second stage, which shows considerable resistance to irradiation, combined arsenic-roentgen treatment is generally effective. As the patient's general condition is bad, as a rule, the doses of arsenic must be smaller than those in the simple arsenic treatment of the first stage. The roentgen treatment should be in the form of divided fractional dosage. (For a detailed discussion of simple, divided and protracted fractional irradiation see Schinz, Hans, *Strahlentherapie*, 1930, *37*, 31.) Protracted fractional dosage is very effective but the authors have not had sufficient experience with it to pass judgment on the advisability of its use in this stage. They gave total irradiation by Teschendorf's method in one case with very good results. In the third stage bone marrow function is in very much worse condition and roentgen treatment is rather dangerous. Possibly in this stage too very gradual protracted fractional treatment would give better results than simple fractional or divided fractional treatment. The latter is apt to cause increased production of myeloblasts. But the treatment of choice is arsenic medication supplemented by blood transfusion which has a good effect on the hemorrhagic diathesis and helps to relieve the injured erythropoietic system.

These stages cannot be differentiated in lymphatic leucemia in which resistance to irradiation does not develop until much later than in the myeloid form. Combined arsenic-roentgen therapy seems to be the treatment of choice from the beginning. Divided fractional treatment proved very effective in the author's cases.—*Audrey G. Morgan.*

LEVIN, ISAAC, Radiotherapy and surgery in advanced cancer of the breast. *J. Am. M. Ass.*, March 19, 1932, *98*, 977–981.

While the value of radiotherapy and surgery in cancer has been generally established the relative value of the two agents in various stages of carcinoma of the breast remains unsettled. Superficial statistical study of large groups of cases is of little value due to variation in behavior of tumors of different types and also to the difficulty of accurately judging and comparing the work of different therapists. The benefits of radiation therapy in far advanced or recurrent cancer being admitted, it should be even easier to obtain good results in early cases.

The author divides advanced cancer of the breast into eight groups with recommendations as to treatment for each, as follows: (1) Cases showing only axillary metastases and movable breast—radical surgery followed by irradiation; (2) as above, with added involvement of paraclavicular nodes—treatment as in Group 1; (3) ulcerated, movable tumors—irradiation before and after surgery; (4) tumors attached to the chest wall—irradiation, followed by surgery only if the tumor becomes movable; (5) local recurrence—treatment as for Group 4; (6) metastases to the lungs—irradiation; (7) metastases to the skeleton—irradiation; (8) general metastases or liver involvement—no therapy effective.—*E. W. Hall.*

BRAUN, H. Beitrag zur einfachen Bestimmung der Lage von Portio und Uterus in der gynäkologischen Röntgentherapie. (Simple determination of the position of the portio and uterus in gynecological roentgen therapy.) *Strahlentherapie*, 1932, *44*, 793–796.

Many errors would be avoided in gynecological roentgen therapy if the roentgen therapist would always determine the line of intersection of the sagittal, horizontal and transverse planes in which the uterus lies and project it on the skin. This can easily be done in large hospitals but the author has devised a simple instrument by means of which it can be done by the general practitioner. It consists of a long transverse and two short lateral limbs marked in centimeters. They are movable in slits in the long limb. He assumes that the normal distance of the portio from the lower border of the vulva is 9–10 cm. and that of the body of the uterus 12–13 cm. A board about 60×40 cm. in size is placed under the pelvis of the patient and she is laid absolutely parallel to it. The sagittal plane is determined by drawing a straight line on the surface of the body from the umbilicus to the symphysis in the midline, or if the uterus is deviated, in the direction of the devi-

ation from the midline. To determine the transverse plane, the instrument is laid with the upper border of the transverse limb at the lower border of the vulva and the lateral limbs pulled out until they rest against the patient's thighs and fixed there by the screws. To adjust for the portio 9 or 10 cm. is read off from the bottom of the lateral limbs or for the body of the uterus 12–13 cm. Say, for example, 10 cm., and this place is marked on the skin on both sides of the body and a line continued backward from this point. To determine the horizontal plane the instrument is lifted up over the abdomen so that the lateral limbs rise perpendicularly from the board. The transverse limb is then moved down in the slits in the lateral limbs until it exercises about as much pressure on the abdomen as is to be exercised in the irradiation. The depth of the pelvis, say 24 cm., is now read off from the scale on the lateral limbs; as the uterus is assumed to lie about midway in the depth of the pelvis a horizontal mark is made on the side of the body at a depth of 12 cm. The intersecting point of the two lines gives the interesection of the horizontal planes in which the portio or uterus may be assumed to lie and on which the central ray should be directed. Of course anomalies caused by descent or retroflexion of the uterus, adhesions or lateral displacements of the organ must be taken into consideration.

The method makes no claim to absolute accuracy but it is a method of projecting the position of the portio or body of the uterus on the skin quickly and with relative accuracy and so determining the position of the central ray. The instrument and the method of its use are illustrated.—*Audrey G. Morgan.*

Jones, Thomas E. Treatment of carcinoma of the cervix. *J. Am. M. Ass.*, Sept. 10, 1932, *99*, 880–883.

Roentgen rays and radium are now the method of choice in treatment of carcinoma of the cervix as shown by an analysis of the literature since 1900. Diagnosis has been frequently discussed and emphasized but cases still reach the therapist in as late a stage as in 1920. Diagnostic failure may be due to insufficient examination with dismissal of symptoms as due to the menopause, or to failure to recognize a discovered lesion as malignant. Biopsy should be used in every doubtful case and may be used without fear of harm. The fallacy that irradiation may cause spread is said to be one cause for delay.

Technique in radiation therapy is yet unsettled but the advocates of massive doses seem to be in the majority. The author uses about 3,600 mg-hr. of radium with 1.5 mm. of brass with tubes in the cervix, fundus and vaginal vault. An inlying catheter keeps the bladder empty. Three or four weeks later the patient returns for a series of high voltage roentgen treatments.

Hemorrhage is usually the result of natural progress of the disease but may be due to radium. Bladder and rectal symptoms, irritation, pain, and tenesmus developing six to eight months after treatment must be recognized, as additional treatment in the belief that they are due to recurrence of neoplasm may do irreparable damage. Cleansing, olive oil and local sedatives allay rectal symptoms; rest, irrigation and gomenol are prescribed for bladder symptoms. Surgery is indicated if fistulas develop as a result of irradiation.

A series of 303 cases treated between 1920 and 1931 gave 25 per cent alive and well after five years, 29 per cent from three to five years and 61 per cent living under three years.—*E. W. Hall.*

MISCELLANEOUS

Christiani, Edmund. Die Senkungsreaktion der roten Blutkörperchen unmittelbar vor und nach Röntgenbestrahlungen. (The sedimentation reaction of the red blood corpuscles immediately before and after roentgen irradiation.) *Strahlentherapie*, 1932, *43*, 126–139.

The author's conclusions are based on the examination of 100 patients with various diseases. In many cases roentgen irradiation increases the rapidity of sedimentation of the red blood corpuscles; it only rarely slows it. In about half the cases there was no change in sedimentation immediately after irradiation. Patients with the same diseases did not react uniformly to irradiation, except those with joint rheumatism and bronchial asthma, none of whom showed any change after roentgen irradiation, and those with lymphatic leucemia, in all of whom the rapidity of sedimentation was increased after irradiation. The effect of irradiation on sedimentation passes off in a little while. No general rules of any kind could be worked out. No conclusions in regard to the action of

the rays can be drawn from observation before and after irradiation. Animal experiments were equally inconclusive.—*Audrey G. Morgan.*

HELD, A. Thorotrast and Infektion. Zur Frage der Blockade des retikuloendothelialen Systems. (Thorotrast and infection. On the question of blockage of the reticulo-endothelial system.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1932, *45*, 330–334.

The author performed a series of experiments in mice and rabbits with the purpose of studying whether the storage of thorotrast in the reticulo-endothelial system has any effect on the course of infections. He found that mice whose reticulo-endothelial system was loaded with thorotrast showed the same course in pneumococcus infections as mice without thorotrast. He further found that rabbits which formed hemolysins against human blood showed, a few hours after thorotrast injections, a decrease in the hemolysin titer of the blood.

From these experiments the conclusion is drawn that a decreased resistance of the reticulo-endothelial system develops only during the course of the actual storage of the thorotrast. Once the storage is completed, no further impairment of the resistance mechanism against infections is to be feared.—*T. Leucutia.*

BUCKY, G., and LEITNER, Z. Biologische Beobachtungen bei der Speicherung von Thoriumdioxydsol. I. Phagozytose. (Biological observations on the storage of thorium dioxide sol. I. Phagocytosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1932, *45*, 561–565.

The authors performed a series of experiments, especially in rabbits, for the study of the effect of thorotrast on the reticulo-endothelial system. In this article the experiments dealing with the study on phagocytosis are published. The method consisted of producing artificial exudates in the peritoneal cavity of rabbits, according to the procedure of Hamburger, by repeated injections of 200 c.c. of physiologic saline solution. The exudate was then withdrawn and the phagocytic power of the leucocytes determined for a specially prepared rice flour. The technique of procedure as well as the results obtained is described in detail. It was found that whereas in the normal control animals the phagocytic power was about 38 per cent, in the animals which had received thorotrast six to twelve months previously, the phagocytic power was only 4.2 per cent, in spite of the fact that all these animals showed no demonstrable injury from the effect of the thorotrast otherwise. The decrease in the phagocytic power of the leucocytes sets in within a few hours following the administration of small doses of thorotrast (corresponding to the doses administered in the human) and reaches its maximum within several months.

Since phagocytosis constitutes a proved biologic test of the vital functions, the authors, on the basis of their experiments, definitely reject the use of thorotrast for diagnostic purposes in the human.—*T. Leucutia.*

KRUMEICH, ROBERT. Über das Säure-Basen-Gleichgewicht beim Genitalkarzinom der Frau. (Acid-base balance in genital carcinoma in women.) *Strahlentherapie*, 1932, *43*, 727–738.

The author first reviews the literature on the subject of acid-base balance in carcinoma. He discusses the regulatory mechanisms of the blood and the defects of the methods heretofore used in this question. He then describes his own method which makes it possible to determine directly the blood content in weak fixed acids.

In carcinoma that is in the beginning stage clinically the blood shows alkalosis. With the further development of the carcinoma, acids are produced which shift metabolism in the acid direction. The increase in acid products of metabolism runs parallel with the development of the disease. In very advanced cases of carcinoma of the female genitalia there is intense acidosis.—*Audrey G. Morgan.*

KÖRBLER, JURAJ. Rote Fluoreszenz in Krebsgeschwuren. (Red fluorescence in cancer ulcers.) *Strahlentherapie*, 1932, *43*, 317–326.

The author has observed a peculiar red fluorescence in some superficial cancer ulcers. It has a metallic sheen with a coppery tint quite unlike the bluish-white fluorescence of horny material such as the finger nails. It is hard to photograph this fluorescence but he has succeeded in doing so by a special method which he describes. Examinations showed that the fluorescence was not produced by necrotic tissue or by the bacteria contained in the ulcers. It is contained in the secretion from the ulcers as the bandages when removed showed a distinct metallic fluorescence. It is seen only in

superficial cancers, never in the operation specimens from deep ones. The tumors in which it was most marked were flat pavement cell carcinomas. Pieces of fluorescent tissue kept in tubes remained fluorescent for two to three weeks after which they gradually lost the fluorescence.

The author concludes that this red fluorescence is caused by the formation of hematoporphyrin while the bluish-white fluorescence of the finger nails and of deep tumors is caused by processes of cornification. These fluorescent substances are probably indicators by means of which other processes of metabolism may be followed up. Fluorescence is caused by the invisible part of the spectrum and so extends the spectrum, bringing into the range of vision new possibilities of investigation.—*Audrey G. Morgan.*

Cappelli, Luigi. La celluloide come supporto nelle applicazione radiumterapiche. (Celluloid as a support in the application of radium.) *Radiol. med.*, Jan., 1932, *19*, 45–52.

Instead of giving a dose of radiation that will kill the cancer cells outright the author prefers giving a dose that will simply paralyze their capacity for karyokinesis so that the tumor will die in time. This requires a much smaller dose and the normal tissues are not injured. He finds Columbia paste is not a good support for radium with this method but that celluloid is preferable. He calls this the method of radio-amitosis. He describes the technique of making the celluloid supports.—*Audrey G. Morgan.*

Ledoux-Lebard, R. Comment faut-il regarder les images radiographiques? (How should one view roentgen images?) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1932, *20*, 188–190.

The author believes that a standardization for the viewing of roentgenograms (negatives, positives or typographic reproductions) should be introduced. The simplest method appears to be the roentgenoscopic orientation. Any roentgenogram should be viewed as if presenting the roentgenoscopic image, the patient being situated between the roentgen source and the observer and the roentgenogram taking the place of the screen. Precaution must be taken, however, to mark the side of the film which is toward the observer.—*T. Leucutia.*

Béclère, Henri. L'examen radiologique en position "pied au plafond." (Roentgen examination in the position "feet toward the ceiling.") *Bull. et mém. Soc. de radiol. méd. de France*, May, 1932, *20*, 251–252.

The position is that of an exaggerated Trendelenburg, the patient being practically suspended by the feet. The legs and knees are fixed by means of belts to the end of a tilt table and then the table is rapidly brought into the vertical position with the head down. It takes only a few seconds to complete such an examination. The method has a great advantage in certain cases, as for example, in impacted fractures of the neck of the femur, in pleural effusions, or pulmonary cavities, in ureteral kinkings, in lesions of the greater curvature and cardiac end of the stomach, etc.—*T. Leucutia.*

Nielsen, Jens. Chronic occupational ray poisoning; a discussion based on a case of leucemia in a radium worker. *Acta radiol.*, 1932, *13*, 385–394.

A nurse forty-seven years of age died Oct. 22, 1930, from myeloid leucemia. Except for a break of about a year she had been connected with the Radium Station in Copenhagen since 1917. During all of this time, in addition to nursing and laboratory work she had helped in the packing of radium preparations. She showed rather pronounced atrophy of the skin of all her fingers with fissures and changes in the nails, but no ulcers. In 1928 she began to feel tired and run down but continued her work. In September, 1929, she was found to have myeloid leucemia. She grew progressively worse until her death in October, 1930.

On the basis of this case and 16 collected from the literature the author discusses the question of whether irradiation ever causes leucemia. He concludes that the evidence is not sufficient to settle the question one way or the other but so long as it is unsettled periodical blood examinations should be made of all persons working with radium and roentgen rays, and on the beginning of any suspicious signs the work should be discontinued or further means of protection used.—*Audrey G. Morgan.*

Lacassagne, A., and Nyka, W. Localisations du radium E associé au bismuth, après injection à un animal cancéreux. (Localization of radium E associated with bismuth after injection in a cancerous animal.) *Radiophys. et radiothérapie*, Volume 2, No. 4, 595–613.

Kahn and Wirth in 1927 injected a colloidal bismuth preparation in an isotonic glucose solution (Bi-diasporal 360) into patients suffering from inoperable cancer and found that the radiosensitivity of the tumor became considerably increased by the storage of the bismuth. Other investigators, however, who used the same bismuth compound failed to arrive at similar encouraging results. Therefore the authors decided to determine experimentally the amount of bismuth which is deposited in the various organs and within the cancer. For this purpose they used the so-called auto-historadiogram method which consists in the injection of bismuth mixed with radium E, which is its isotope, and the determination of the radioactivity of this latter from the ashes of the organ in question. The experiments were carried out on cancerous mice and in rabbits which were grafted with the Brown-Pearce tumor. It was found (1) that the bismuth does not show an elective storage in the cancer cells; (2) there is no important difference between the organotropism of radium E and that of other radioactive substances. Like these, radium E is encountered chiefly in the cortical substance of the kidneys, in the liver and in the reticulum of the hematopoietic organs; (3) the proportion of radium E retained in cancerous tissues varies with the histologic type of the neoplasm. Thus the Brown-Pearce tumor of the rabbit retains about the same quantity as the liver, which is greater than that retained by the mammary adenoepithelioma of the mouse. This latter contains radium E (and bismuth) in a still lesser proportion than the blood-forming organs; (4) the blood alterations produced by the injection of radium E within the limit of the doses employed in the experiments are slight and reparable. Still these doses have attained the limit of toxicity, at least for the mice; in the rabbit the treatment led to sclerotic interstitial nephritis, producing death within a few months. In spite of all this, the radioactive substance proved without effect on the cancers used in the experiments. In none of the cases was there evidence of cytologic alteration, arrest of growth of the cancer or prevention of metastases.—*T. Leucutia.*

TAYLOR, A. G. C. On the action of radium D, E, and F with colloidal bismuth upon growing tumours. *Brit. J. Radiol.*, May, 1932, *5*, 446–456.

Lacassagne and Kahn (see above abstract) have shown by the "autohistoradiogramme" method that tumors can be made to take up radioactive salts. The author investigated the different effects of bismuth and radium D, E and F on the growth of Jensen's rat sarcoma and estimated their possible use in radium therapy. The radioactive principles used were the natural decay products of radon which had served in therapy as seeds. These were ground up finely and the radium D, E and F extracted with dilute (0.4 N) HCl. The solution was nearly neutralized with NaOH and then evaporated to dryness, the radium D, E and F being contained in the NaCl crystals. The active salt was measured under a beta-ray electroscope, weighed and made up into solutions of desired strength. The activity was expressed in "Emans." The bismuth preparation used was "wismuth-diasporal inactive," a colloidal solution in glucose, 1 c.c. of the solution containing about 3.4 mg. of bismuth. The experiments have been divided into three groups: (1) the effect of a solution of radium D, E and F on emulsion of Jensen's rat sarcoma; (2) the effect of bismuth and radium D, E and F when injected around young growing tumors, and (3) the effect of bismuth and radium D, E and F when injected in the opposite flank to the growing tumor.

The conclusions were reached that arrest of tumor growth was obtained by giving injections such that there has been a close contact between the radioactive solution and the growing tumor and such that the strength of the solution has been sufficient to produce severely toxic or lethal effects on the rats. It has been shown, however, that radium D, E and F in a concentration that would not be severely toxic to a rat is in vitro lethal to Jensen's rat sarcoma. The results of these experiments have not been very encouraging but it does seem possible that radioactive solutions may find a place in therapy if a satisfactory method of applying them directly to tumor cells can be found.—*T. Leucutia.*

KADRNKA, S., and JUNET, R. Recherches expérimentales sur l'opacification radiologique de divers organes parenchymateux par injection intraveineuse de thorotrast (moelle osseuse, poumons, reins, placenta et surrénales). (Experimental researches on the roentgen opacification of various parenchym-

atous organs by intravenous injection of thorotrast (bone marrow, lungs, kidneys, placenta and suprarenals).) *J. de radiol. et d'électrol.*, Dec., 1932, *16*, 598–604.

By administering increasing colloidal doses of thorotrast intravenously in animals the authors were able to obtain, in addition to the visualization of the spleen and liver, a more or less pronounced opacification of the bone marrow, lungs, kidneys, placenta and adrenals. This biological phenomenon is interesting since it proves what has already been demonstrated through numerous other experiments by Askanazy that the filtration of the blood is the result of the combined function of the stroma and of the parenchyma.

The parenchyma filters the usual products of metabolism which are in the form of finely dispersed bodies and soluble substances or more rarely in the form of molecular and micellar elements. Such a process occurs chiefly in the parenchyma of the kidneys, lungs, liver, skin and mucosa (elimination of heavy metals in the colon) and corresponds in general to the excretory function of the body. Certain organs, in addition, extract from the blood substances which are necessary for their specific function, such as iodine by the thyroid gland and Cl ion by the gastric mucosa.

The filtration of the stroma, which is the more important from the point of view of the authors' experiments, was assumed by the School of Geneva on the basis of current anatomo-clinical observations as, for example, those made in general anthracosis or in hemomelanosis secondary to malaria. The principal organs showing a filtrating function of the stroma are the spleen, liver and bone marrow. These organs extract from the blood directly foreign bodies which are present in a coarse or more often in a fine aggregating suspension as for example, carbon, metallic hydrosols, etc.

Both the above said filters are called primary in contradistinction to the function of the lymphatic system which is called the secondary filter of the blood.

Following such a theory, if ThO_2 hydrosol is injected into the blood the micella are absorbed by the endothelial cells of the capillaries, this corresponding to the first phase of the filtration of the blood by means of the stroma. Shortly afterwards the thorium dioxide is noticed in the reticular cells of the spleen, liver and bone marrow, which then forms the second phase of the filtration of the blood by means of the stroma. Whereas the passage of the blood within the endothelium and from the endothelium to the reticulum is quite rapid, the sojourn in the reticular cells is more prolonged, sometimes lasting for a long while. Indeed, the appearance of cells containing thorium granules in the lymphatic system, this forming the third phase of filtration, may not occur until very much later (in certain sacrificed rabbits fourteen to eighteen months after the injection). The stroma of the spleen, liver and bone marrow, acting in the manner described above as primary filter of the blood, extracts the thorium particles introduced through the blood stream and renders these organs opaque to roentgen rays during the second phase of the process (from several hours to several months after the injection). During the third phase of filtration, which usually occurs during the year after the injection, the roentgen image may entirely change due to displacement of the thorium into the lymphatic system.

After this theoretical consideration the authors discuss in detail osteomyelography, pulmoalveolography, nephrography, placentography, and adrenalography produced by the injection of thorotrast, emphasizing the fact that the technique of administration of the thorotrast is of primary importance. The authors themselves proceed by injecting intravenously small doses (10 to 30 injections made at twenty-four to forty-eight hour intervals) until a sufficiently large total dose is reached to produce an opacification of the desired organs. It must be mentioned, however, that so far the procedure has been applied only to animals and that thus it is as yet of purely theoretical interest. Besides, the total doses, except those utilized for the placentography and osteomyelography, must be so large that microscopically demonstrable lesions of the organs examined are produced. But even for placenta and bone marrow the possibility of tissue alterations cannot be entirely excluded.

In another series of experiments the authors tried to block the reticulo-endothelial system by various means such as intravenous injection of china ink, pyrol blue, lithium carmine, metallic hydrosols of copper, gold, iron, etc., either before or after the injection of thorotrast so as to produce an accumulation of the injected thorotrast, but so far the experiments have remained unsuccessful.

As a conclusion of all the work done up to the present, the authors state that although the method has remained valueless in its practical application in the human, it will prove of great importance in the study of biologic and physiopathologic phenomena.—*T. Leucutia.*

JOLY, MARCEL. Théorie personnelle de l'action des radiations de courte longueur d'onde sur les cellules vivantes. (Personal theory of the action of radiations of short wave length on living cells.) *Bull. et mém. Soc. de radiol. méd. de France*, Feb., 1933, *21*, 103–106.

Various theories have been advanced for the explanation of the radiation effect on the living cells such as the point-heat theory of Dessauer, the theory of photo-electric mutations of Holfelder, the necro-hormone theory of Gaspari, the radiotoxin theory of Regaud, the lymphocytic reaction of Murphy, etc. The author now proposes a new theory which is as follows: Every living cell is obligatorily composed of electrons in motion inasmuch as life implies motion and heat equally implies motion. According to the theory of de Broglie, an electron in motion implies the electron itself and the associated wave, the two forming an indissociable ensemble. If one of them is disturbed, the ensemble, that is the electron in motion and in consequence, life itself, will be disturbed. The associated wave is subject to the law of all waves and in particular to the law of interference. One may therefore assume that an associated wave projecting in its direction might be annihilated by another wave of a suitable length. It is not improbable that a similar condition occurs when one directs a roentgen-ray beam on the living cells. It suffices that the synchronism of the frequency of associated waves and of the roentgen rays be perfect and their direction opposite to provoke an interference, with the resulting annihilation of the associated wave, arrest of the electrons and death of the cell. To verify this hypothesis several experiments are in order.—*T. Leucutia.*

TENEFF, S., and STOPPANI, F. Étude radiographique sur la circulation lymphatique et sur les ganglions lymphatiques. (Roentgen study of the lymphatic circulation and of the lymph nodes.) *J. de radiol. et d'électrol.*, Nov., 1932, *16*, 533–537.

The author studied the lymphatic circulation in living animals by injecting thorotrast which is easily absorbable by the peripheral lymphatics and accumulates in the lymph nodes without, however, producing any serious injury to the tissues. Experiments were carried out on guinea pigs by injecting subcutaneously 1 to 2 c.c. of the thorotrast in the hind legs. Roentgenograms were taken immediately after the injection, as well as half an hour, 7 hours, 1 ,5, 10, 15, and 20 days afterward. The animals were killed on the 10th, 15th or 20th day, an autopsy performed and the popliteal, inguinal and lumbo-aortic lymph nodes removed for histologic examination. By this method the authors were able to study the entire course of the peripheral lymphatics and the relation of the lymph nodes to other organs. It is nearly a century since Sappey, Panizza, and others, studied the lymphatic system by injecting mercury into the lymphatic ducts in the cadaver and by investigating their distribution in the secondary lymphatic branches. It is possible now by this new method to study the lymphatic system in the living with nearly mathematical precision. Roentgenology has brought here an important contribution by opening a field which, when thoroughly exploited, will lead to noteworthy practical conclusions in human pathology.—*T. Leucutia.*

REISNER, ALFRED. Der Hauterythemverlauf bei fraktionierter Verabfolgung grosser Strahlenmengen. (The skin erythema course in fractional administration of large amounts of radiation.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1932, *45*, 293–307.

The author has carried out a series of experiments on the skin erythema by divided doses. Tables and curves were established giving the tolerance limit of the skin for daily irradiations (at twenty-four hour intervals) with fractions of 90 per cent to 10 per cent of the individual dose. It was found, for example, that if the dose was split in two, the first visible decrease in the intensity of skin reaction was observed when the fractions were administered at eight-hour intervals. At four hours there was no change and at twelve hours there was a very marked decrease. The magnitude of the fraction administered at one time proved to be of paramount importance. Thus, with like doses the erythema was considerably more pronounced when individual fractions were given at two-day intervals than when the same fractions were split into half fractions given at daily intervals. The time factor was of no less

importance. Even with prolonged intervals a greater reaction was obtained when the last fraction was administered at the beginning of the second phase of the erythema.

The experiments prove beyond doubt that a further study of the rhythm of the reaction is necessary. More favorable tolerance conditions of the skin will be found by skillfully choosing the individual doses and the time interval between them.—*T. Leucutia.*

Bayer, Ludwig. Über Adaptation für Röntgenzwecke. (On adaptation for roentgen purposes.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1931, *44*, 782–784.

The author analyzed the value of Ganter's method in subjecting only one eye to adaptation for roentgen examination. He used a black goggle for one eye for a period of fifteen to thirty minutes, the other eye being left uncovered. When entering the roentgen room the goggle was removed and a roentgenoscopic examination attempted. It was found that the removal of the goggle was followed by a very intensive light appearing in the unprotected eye, by marked asthenopic symptoms (pain in the eyes due to dissociation of the accommodation impulse) and by a distinct strabismus divergence of the unadapted eye due to difficulty in converging. For this reason it was thought that the method of adaptation of one eye may be discarded.—*T. Leucutia.*

Gunsett, A., Sichel, D., and Bouton, E. Notre expérience du tube Rotalix, alimenté par un appareil à courant triphasé dans la téléradiographie pulmonaire. (Our experience with the Rotalix tube, fed by a three-phase current apparatus in pulmonary teleroentgenography.) *Bull. et mém. Soc. de radiol. méd. de France*, Nov., 1932, *20*, 564–566.

In this article the authors report their experience with a Rotalix tube, utilizing a six-kenotron, three-phase current. They state that a four-kenotron generating apparatus can also be used for the feeding of the tube but that in this instance the apparatus must furnish at least 400 to 500 ma. Because of the very fine focus a distance of 1 meter 50 cm. is entirely sufficient to obtain very excellent results. Over 700 pulmonary roentgenograms were made with the tube without its showing any signs of breaking down. A disadvantage is that it cannot be used for roentgenoscopy. During the discussion which followed, Dr. Nadaud stated that the tube has several disadvantages such as the high price, the limited life duration, that it can be used only for pulmonary roentgenography, that it throws too pronounced shadows of the thoracic cage obscuring certain details of the pulmonary field and that there is an absence of detail in the more massive processes due to the rather low tension which is obligatory for the good functioning of the tube. In response, Dr. Gunsett said that he agreed that the high price and the limited use of the tube are certain disadvantages but he stated that the undue projection of the thoracic cage can be overcome by a simple change of technique and that a better definition of the more massive shadows can be obtained by simply increasing the voltage.—*T. Leucutia.*

Nemours-Auguste. Présentation d'une nouvelle grille radioscopique et radiographique. (Presentation of a new roentgenoscopic and roentgenographic grid.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1932, *20*, 213–216.

The author endorses the grid which was constructed by Schonaunder of Stockholm. It is a flat grid only 3 mm. thick and very light. It can be attached to any roentgenographic table. It gives excellent results in the study of the lungs, heart, mediastinum and digestive tract. Since the time of exposure is only 30 per cent longer, excellent lung exposures are obtained with 2 ma-sec. at 1.80 meter distance.—*T. Leucutia.*

Solomon. Le service d'etalonnage des ionomètres de l'hôpital Saint-Antoine. (The standardization service of ionometers at the St. Antoine Hospital.) *Bull. et mém. Soc. de radiol. méd. de France*, March, 1933, *21*, 287–290.

Conforming with the decision of the Third International Congress of Radiology at Paris to compute the French R in the international r, the author has installed a standardization service at the St. Antoine Hospital in Paris. There are especially two methods for the changing of the R into the r. The first is through the changing of the distance of the radium used as a standard source from the ionization chamber. The researches of Glasser and of the author have shown that if this distance is reduced from 2 cm. to 1.4 cm., the amount of ionization measured will correspond to the international electrostatic unit r, the R thus becoming equal to the r. This method, however, has several dis-

advantages which make its practical application quite cumbersome. The second method is through comparison with large ionization chambers. In order to obtain correct results from this method it is necessary to first standardize the procedure. The author has arranged a standardization service which briefly includes the following apparatus and instruments: (1) a pulsating current generator giving from 60 to 200 kv. and feeding an air-cooled tube; (2) an ionization measuring device which is completely insulated from the generator and the tube. A suitable orifice permits the direction of the ionizing beam on the large standard ionization chamber and on the small ionization chamber to be standardized simultaneously. For the purpose of comparison the author uses two large ionization chambers, one similar to that of the ionization chamber of Schechtmann and the other similar to that of Taylor of the Bureau of Standards of Washington. It is the author's opinion that this latter will with time become the international standard chamber because of its many advantages: its dimensions are quite small, making the transportation easy, the electronic utilization is complete, the distortion of the field is prevented, etc. Furthermore, this chamber was directly compared with that of the Physikalische Reichsanstalt, Berlin, and of the National Physical Laboratory of England. The zero method of Townsend is utilized as in the case of Taylor for the reading. The irradiating beam is limited by a circular diaphragm of 7 mm. diameter at the entry into the chamber. The author placed at the posterior part of the lead box containing the chamber a roentgenoscopic centering device with two cross wires. The small ionization chamber of the ionometer to be standardized is placed as close as possible, however, without throwing a shadow, to the beam admitted into the large ionization chamber so that the two chambers are irradiated simultaneously by a beam emerging from the same anticathode target. Without this precaution the two chambers may be irradiated by a radiation which is of different spectral composition.

Every ionometer to be standardized is subjected to the following measurements: (1) standardization in r for a tension of 200 kv. and filtration of 0.5 mm. Cu; (2) verification of the independence of the wave length of the small ionization chamber and in case of dependence determination of a standardization curve; (3) verification of the gradation of the scale of the ionometer.—*T. Leucutia.*